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TYPEWRITING BEHAVIOR

Dr. Frank Bunker Gilbreth

TYPEWRITING BEHAVIOR

Psychology applied to teaching and learning Typewriting

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TYPEWRITING BEHAVIOR
W. P. 2

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DEDICATED

TO

FRANK BUNKER GILBRETH

A brilliant and dominant personality in American engineering, a pioneer in scientific motion studies that seek the "one best way" of typing.

EDITOR'S INTRODUCTION

Typewriting is an essential part of basic preparation for many office positions. It is a desirable element in programs of training designed to prepare for unspecialized office work. It is rightly emphasized as a legitimate part of any full program of business education.

Typewriting is a facilitating subject which, if properly presented, can be made available to many who do not now have the time for it. College students and educated people in general can make good use of typing ability in the conduct of their personal affairs. The use of this writing device should be greatly extended among those who have no real vocational need for it.

As at present taught, typewriting is about the most time-consuming subject in any educational program on any level. This is not necessarily a reflection on the rank and file of typewriting teachers. They have made the best possible use of available instruction material and methods while awaiting results of research in this and the related field of educational psychology. Those who normally would pursue typewriting for its personal utility value are loath to do so because of the time element involved. Those who pursue it for vocational reasons devote more time to it than they can afford — far more than should be required — often at the expense of other vocational and background subjects. Between two and three full years — often more — are needed for the rather low degree of mastery required in this subject. This is too much. What can be done about it?

In the first place, the aims for this course can be reduced to two: (1) mastery of typewriting techniques and (2) development of typing ability through adequate instruction and practice in the application of these techniques in dealing with practical typing situations.

In the second place, the time-consuming, discouraging nature of much of our instruction material may be conceded in the light of results obtained with new material resulting from scientific study and experimentation.

In the third place, a scientific attitude may be adopted in the teaching of this subject. The results of research in the form of better methods may be accepted, even though they do violence to long-established procedures.

Simplification and clarification of aims, modernization of instruction material, and the development of scientifically sound instructional methods should go far toward establishing typewriting in its rightful place as a part of public and private programs of education.

It will be difficult for older teachers, and younger ones who have been taught by them, to concede the possibility that the requirement of "accuracy" has been overdone, that "technique" (form, in the athlete's sense) is to be striven for at all stages in the pupil's progress, that "speed" or fluency in the early stages of training should be developed, even at the expense of accuracy, that ability to type from plain copy is not an adequate measure of *typing ability*, that making a fetish of *touch typewriting* at the outset in student training is a serious barrier to progress in learning to type, and that much more *direct dictation* is a prime requisite in the training of a typist. But these possibilities and others are well worth exploring in the interest of more efficient teaching.

During the last decade of the nineteenth century and the first decade of the present century most of the methods impliedly challenged above were established as a result of bitter controversy. They represented real progress over what had been accepted practice up to that time, but their genesis was by no means sufficiently scientific in the modern sense to justify attaching to them the qualities of infallibility and immortality. Yet these methods and beliefs have persisted with relatively little change through the score or more of years since their adoption. This may or may not account for the fact that while championship typing records in *words a minute* have been improved, it still requires as much, if not more, time to train one to operate a typewriter up to reasonable standards required for personal and vocational work as it did a score or more years ago. In the light of progress made in the development and practice of other manipulative skills it is difficult to escape the conviction that there has been serious lagging in this field of training and that this retardation is largely due to the absence of scientific research and the consequent persistence of traditional aims, instruction material, and methods of teaching.

For the past several years, aided by financial grants, unusual facilities for pursuing research studies, and adequate opportunity for practical experimentation, Dr. Dvorak, Miss Merrick, Dr. Dealey, and Miss Ford have labored unceasingly in an effort to find out just why so much time is wasted in the teaching of typewriting, and why the results of such long courses are disappointing. The results of their investigation are set forth in this book which, unlike most reports of research, is not only challenging, stimulating, and enlightening, but also entertaining and easy to read. It does not ignore the "tricks of the trade"; on the contrary it validates many old ones and presents many new ones backed by the results of research. But it goes far beyond these somewhat superficial aids in teaching and directs attention to modern educational psychology and its real implications for better teaching in this field. It bases its methodology on a penetrating analysis of the complex activity which is typewriting, on accepted principles of psychology, on the results of the best work in the field of motion study, and on the outcomes of a prodigious amount of work to determine letter-combination frequencies. It is a book in which factual data leave little room for personal impressions — a real distinction, as most students of the literature in this field will admit.

Trainers of typewriting teachers will find this book indispensable. Progressive teachers of typewriting, experienced and inexperienced, should turn to it for the answers to many perplexing questions which have intrigued them. Mature students of typewriting in junior colleges, universities, and the better private schools will find this book most helpful in their attempt to master accepted typewriting techniques and to develop skill in their practical applications. No leader in the field of commercial education and no teacher who desires to become a leader can afford to miss the benefits and the enjoyment sure to result from a perusal of this most stimulating book. Students of psychology, as well as practitioners in this field, will find much of interest in those sections of the book which deal with the psychological issues involved in learning to type, in teaching the subject of typewriting, or in the general development of skill.

In urging that all the above people should use this new material, it is not necessary to subscribe unreservedly to all the findings which emerge from the research these competent educators have carried on. It is enough to know that it is an authoritative contribution to the improvement of instruction in a field which is sorely in need of overhauling in the interest of hundreds of thousands of students, tens of thousands of hard-working teachers, millions of taxpayers who are assessed unnecessarily because of undoubted inefficiency in the handling of a universally taught subject, a multitude of long-suffering employers who more or less uncomplainingly take over an unfinished training job where teachers leave off, and countless longhand writers who would adopt the machine way of writing if it were not for the excessive cost of time and money involved in learning to type.

In conclusion, it should be emphasized that, contrary to common belief, the results of research done by Dr. Dvorak, Miss Merrick, Dr. Dealey, and Miss Ford are quite as helpful to those who must struggle on with the handicap of the old keyboard as they are for those who are privileged to use the new keyboard recommended by these investigators. It is quite as important to recognize frequencies of letter combinations in the one case as it is in the other. The sound methods of learning and teaching typewriting presented herein are applicable to both types of machine. This book is a comprehensive and intensive discussion of the learning process and of best teaching methods, which any progressive teacher can put into practical use at once, regardless of limitations of equipment. It is no disparagement of the work of other investigators, authors, and teachers in this field to say that this particular book merits attention more surely than does anything else that has been published on this subject up to this time. If you like to be challenged and professionally stimulated, read it.

Frederick G. Nichols

PREFACE

Psychological adventures shared by the college student and his instructor are often hampered by the hurdles of a new and difficult vocabulary. In the present account of typewriting behavior, a genuine effort has been made to depart from the distressing imposition of current vocabulary hurdles upon students interested in or forced to analyze what happens when a student masters typing. Despite this downward toning of vocabulary, a few strange psychological terms may burst through like true Jacks-in-the-box.

The complicated skills that are typewriting bring to a focus every common issue of educational psychology. The up-to-date views of leading psychologists have been brought together. Their suggested solutions are not only illustrated, but also immediately tested in typewriting. One reason is because typewriters are familiar to students. Indeed, today's typewriter offers a student of college psychology what might be called a personal laboratory for concrete tryouts of any ideas about learning. With a typewriter any student can actually experience the changes which transform a clumsy beginner into a person whose faster motions communicate with surprising ease his written thoughts to associates on the American scene. Simultaneously, a psychology student also gains for himself this more fluent, swifter mode of social expression that is displacing sluggish pencils and pens.

The story of a growing typist who is to find superior motions and a machinelike ease in communicating with others nevertheless soon expands to include a more special interest. More and more must this present account address the student who wishes to be both a typist and a teacher of typing. For this reason, typewriting instructors are asked to simplify their insight into the psychology of learning by first watching through student eyes. Each typing instructor is asked to think in terms of the student. By reading this text in student terms, each instructor more readily holds the student as the center of interest. By reading this appeal to any student to solve his own typing problems, the teacher is the more willing to listen when this young typist wishes to talk out his troubles. Such friendly conversation is utilized to size up individual problems. In short, while a student studies typing motions, the teacher studies the student. The latter task calls for the more difficult learning.

Conventional psychology, accordingly, is rewritten in student terms for the student who is analytical about typewriting and for the typing instructor, in order to bring out five ideas about learning. At the same time, as an aid in simplifying a widening scope as the book expands, particular pages are specially selected to appeal to the psychology student, to the student typist, or to the instructor observing through student eyes. Detailed reading suggestions for these different readers accompany every chapter. What, then, are five ideas about learning which are of interest to all these readers?

(1) So-called habits, particularly typing habits, are shifting, conditioned behavior. As an illustration of conditioning to countless slight signals, or cues, typewriting is admirably clear-cut.

(2) Typing improvements are complete behavior *patterns*. Each better typing motion that appears does so as a new, complete pattern, often called by the German term, Gestalt. Such motions are popularly referred to as "good form." Typewriting form, unlike conditioning, the student can learn to observe.

(3) The direction of typing progress is itself a striking *gradient* or slope in muscular activity. Along such slopes each student is impelled toward an easier balance between himself and his typing task in its classroom setting.

(4) Learning to typewrite, like all learning, is chiefly student thinking along a path charted to reduce difficulties and thus reach desired results.

(5) Today this is the fascinating path of *motion study*, long since cleared by Frank B. Gilbreth and associated experts. Glimpses of informal Gilbreth motion-study notes help to clarify this path. These notes and micromotion films of championship typing form, which have helped us to develop a simpler keyboard for the typewriter and its learners, have been generously tendered us by Dr. Lillian M. Gilbreth of Montclair.

The smoothness with which work finally flows through the typewriter is no accident. It is a gradual achievement, which crowns the thinking through of each felt difficulty, day by day. The available aids, accordingly, are marshaled for the student's self-directed study of his own difficult behavior. He looks into his own world, within or without the classroom, to uncover the conditions that surround repeated typing errors. Such errors are only symptoms of underlying interference. All difficult typewriting behavior, or misbehavior, is thus treated with the same psychiatric approach now accorded any "difficult" behavior.

As an important instance of interference, there are errors on even the most common, simple words that can be explained in only one way. These errors are intruding from a crude keyboard, a hang-over from last century's machines with their sewing-machine lines, clumsy foot throw, ugly Gothic capitals, and blind writing. This is the only patchwork still preserved in an otherwise modern typewriter. This "universal" keyboard needlessly handicaps one fourth of all ordinary typing. Actually it uses no genuine home row, but tosses the typing mostly into an upper row of keys. It overburdens lesser fingers and the left hand to an extent quite unrealized. It forces frequent idling of one hand while the other types entire words. Excessive and awkward finger motions that weaken the rhythm, tire the student, and mistreat his record with errors silently block rapid progress. A "simplified" keyboard that practically does away with this tremendous yet hidden interference holds its important place in the pages that follow.

There are no overcaustic broadsides against continuing ignorance of motion and time studies on the part of typing students by the hundred thousands each year. The effects of misleading beliefs and misdirected practice are disheartening enough in their own right. Although this text is addressed to the student, each instructor is asked to check, in student terms, what seem to be the shortcomings of customary usage:

(1) Immediate accuracy is of only moderate importance. Yet even the most awkward beginner is led to feel that "perfect" copying is all-important. If he rebels, he is severely penalized for his rising speed.

(2) Suitable speed is of immediate importance. Monotonously enough, each student hears warnings to go more slowly.

(3) The key to successful typing is in control and relaxation. Students feel themselves urged continuously into a defeatist or overvigorous attack until their excessive tension injures control.

(4) The isolated letter stroke is not even typewriting. Regularly, students are led to believe that they must drill and glorify these isolated letter strokes. Or students are wrongly led to suppose that time spent counting isolated letter errors is the opposite of time wasted in the name of typing skill.

(5) Rhythm is basic in fast typewriting. Often the student is left to feel rhythm as some indefinite ideal; or to think that, like American jazz, music is not quite the proper accompaniment for his typing.

(6) Guides to typing skills are slow-motion pictures, which reveal direct manipulation, correct stroking, and fluency, along with other diagnostic devices to iron out hesitations and bring evenness of timing. The student is forced instead to accept the supremacy of copying from his printed manual. He is persuaded to prefer an expensive mass of manuals to motion study. Not infrequently, his manual is crowded with nonsense drills, early "style" arrangements, incomplete advice, and detailed hocus-pocus serving as distractions rather than aids.

(7) Direct dictation is time saving. Yet a student who feels the boredom in overmuch copying from copybooks often has no alternative. He seldom experiences the regular timing possible in direct dictation.

(8) Sight efficiently guides an awkward finger to the center of a key. At the very start of most touch-typing classes, hapless beginners are driven to believe that it is best to fumble over an unfamiliar keyboard, sight unseen. Each must forego temporary aid from his eyes in order to add the further distraction of having to read copy.

(9) The very keyboard is a haphazard imposition, wretchedly unbalanced, and absurdly awkward in vital reaches. This unnecessary handicap is forced upon all students. Otherwise, they would be faster typists in one semester than the majority will be after one or two years of "Typewriting."

(10) Most practical typing experiences are met in business and industrial offices. These essential experiences are unknown even to advanced students.

Where in America today is there a comedy of errors to match conventional typewriting instruction?

ACKNOWLEDGMENTS

On page 3 of the first chapter of this book — "The Typist's Social Heritage" — the authors state, "Through thousands of years groups of men facing life together have hit upon better ways of living." The authors, like their readers, have been conditioned by the words and deeds of those thousands of men who lived and worked yesterday and countless other yesterdays. Hundreds of references in this volume are evidence of this conditioning. To these writers and their publishers the authors acknowledge their indebtedness.

The motion-study notes, motion-picture films, and other photographic materials loaned by Dr. Lillian M. Gilbreth were a great aid in this study. To the late Dr. Frank B. Gilbreth and to Dr. Lillian M. Gilbreth and to their pioneer works in Motion Study, the authors acknowledge their great indebtedness.

In 1932, Dr. Henry Suzzallo and his co-workers in the Carnegie Foundation for the Advancement of Teaching became interested in the teaching and learning of typewriting. As a consequence, in 1933 and 1934 the Carnegie Corporation of New York through the Carnegie Foundation for the Advancement of Teaching assigned two subventions to the University of Washington to aid a study of typewriting and allied commercial-education problems. The present volume is the first of a series in commercial education to result from this study. The authors' debt to the Carnegie Corporation and to the Carnegie Foundation for the Advancement of Teaching is hereby gratefully acknowledged.

To Dr. Willis L. Uhl the authors are grateful for reading this manuscript, for timely suggestions, and for encouragement and administrative assistance given to this study.

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PART ONE

TYPEWRITING IN SOCIAL SITUATIONS

CHAPTER I

THE TYPIST'S SOCIAL HERITAGE

* * *

READING SUGGESTIONS

To the Student Typist: This entire chapter tells the background of typewriting as a social art and part of America's civilized culture. Especially important is the study of the human hand and of ways inventors extend the use of hands through machines.

To the Psychology Student: A glimpse can be taken of "touch" and allied senses, page 10, or of the hand's reaction mechanism, pages 7 to 11. Yet the chief interest lies in a "double-language" view of thinking, pages 14 to 16.

To the Typing Instructor: Study of the human hand, pages 7 to 11, can be skimmed. An essential section presents typewriting as intelligent behavior (as a result of thinking), pages 12 and 13.

* * *

Is it possible for you to visualize past centuries as faint projections of motion pictures or pageants of innumerable men and women? In the vivid present, can you identify yourself particularly with the past of your chosen vocation and move to shape its future? The role of the typing student has been shaped and dramatized by men and women of the last half century. In every American community the stage has been set by past co-operation and past discovery. Through thousands of years groups of men facing life together have hit upon better ways of living. This vast and total heritage of economic and educational programs, folkways, fine arts, sciences, and inventions is called *culture.* All of us today are more alike than different, because we are molded to these common ways of living. Yet in these changing times we, in turn, seek even better ways by present co-operation and present discovery.

THE OLDEST, GREATEST INVENTION

What is the oldest and greatest invention from the past? In the midst of considering, you may suddenly exclaim, "I have it — it really is language!" During primitive centuries, while men were inventing certain sounds to help control one another's actions, they stumbled upon devices which would carry such human speech further than the unaided human voice.[1] When people were still savages, a few crude pictures served that purpose. Some ridiculous drawing — perhaps a crude map that designated a meeting place — was the only love letter an Indian girl might expect from her Indian "boy friend." Yet it was usable. Perhaps no other famous teacher has told the story of the invention of written language more simply than Judd.[2]

Back in old Egypt's balmy, ancient days, picture drawings came to have indirect meanings. For instance, the spoken symbol used by those Egyptians for *owl* began with the sound *M*. In time, the drawing of an owl began to stand for that very sound. The well-trained Egyptian priests, drawing and redrawing owls to represent the sound *M*, gradually modified the picture until only a few lines were left of the owl's figure. These few simple scrawls really stood for the sound of *M* as well as for the whole picture. Meanwhile, other pictures were similarly modified until the Egyptians had perfected letters known as an alphabet. The old-time Greeks adapted this sound alphabet, borrowed perhaps from wandering sailors. Much later, the practical Romans made use of improved letters with straight lines and sharp angles as chiseled on stone monuments. For ordinary business records in old Rome, clerks soon began to make writing easier and faster by running these letters together with new connecting lines. In time, capitals were added. Finally, ordinary writing became such a hurried scrawl that it was hard to read, and the indignant Emperor Frederick II made a law against it.

Fortunately, with the fifteenth century there came the invention of the printing press. Printers then began to select clear-cut, beautiful letters for their printing presses. The popularity of playing cards gave them wide scope for practicing this new art.[3] Printing grew into one of the great industries. Before it was invented, the cost of writing books by hand had kept books from all but a very few persons. Now giant printing presses dash off millions of printed symbols in cheap newspapers, magazines, government bulletins, novels, and other books. Railroads, electric interurbans, motor trucks, airplanes — invented during past years — speed this printed matter all over the United States. No wonder that every American must learn to read and write language symbols if he is to get along with other people in our workaday world! Without the alphabet, there could be no newspapers, books, public schools, or formal education. Without the alphabet, no postal service could maintain business or friendships between distant correspondents. What other invention in the whole world could mean more to present-day life? What a clumsy world this would be if we, like the ancient savage, had contact with other people only through gesture signs or drawn pictures! Life would be as confused as if one were lost in a foreign country where English was not known or as if one were stricken deaf and mute.

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[1] Van Doren, Carl, "Literature," in *Whither Mankind*, C. A. Beard, Editor (Longmans, Green and Company, 1928), pp. 387–394.

[2] Judd, C. H., "The Psychology of the Alphabet," in *The Psychology of Social Institutions* (The Macmillan Company, 1926), Chapter IX, pp. 160–186.

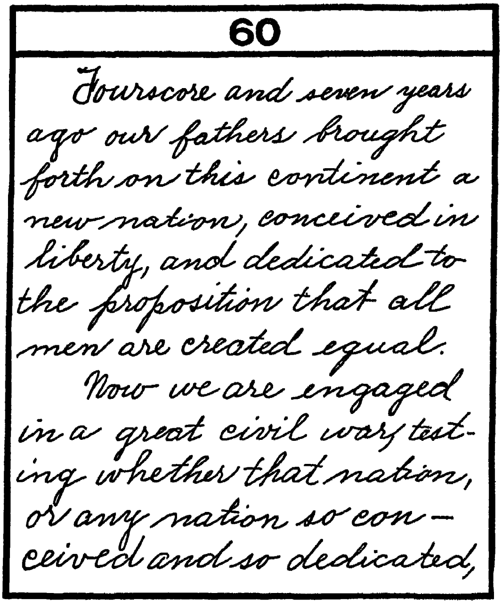
[3] Dixon, R. B., *The Building of Cultures* (Charles Scribner's Sons, 1928), pp. 135–145.

Yet a wide gap remains between comparatively slow, toilsome handwriting and the fast, easy precision of printing presses. All too readily this slow, laborious handwriting is crowded into a faster scrawl that is barely legible. All too expensive and elaborate for everyday personal use are the precise printing presses. But the gap between handwriting and printing would be much wider today if new inventions were not already available. Handwriting, for business purposes at least, is as outworn in modern America as was picture writing in ancient Greece. The possibilities in the human hand are far greater than any pen or pencil can release.

PERSONAL HANDWRITING

Pupils still practice handwriting movements of arm and fingers for years in grade schools, until each records ideas for permanent keeping or for conveyance to others at a distance. At least, by virtue of this sluggish handwriting, none of these children needs to be face to face with the person thus addressed.

Outside these schools, typewriters have been widespread for over a generation. Yet as a student typist you now make your first formal contact with a writing machine! In all probability as a youngster you, too, once took a good position and practiced easy, sidewise movements across a sheet of paper. Your fingers and arm — and many other muscles of your entire young body — were very active. Doubtless you are now able to relax many of these muscles and avoid the wasteful movements of hand and wrist found in poor writers. Rhythm, as always, now helps your speed. You divide movements with definite, intervening pauses to fit the natural forms of letters. Only the poor penman writes words in an unbroken movement, forgetful of form. To satisfy yourself on this point, reach for a piece of paper and write the word *fox*. Observe the finger movements. If you are a good writer, as told by Reed,[4] you make mo-



60

Fourscore and seven years ago our fathers brought forth on this continent a new nation, conceived in liberty, and dedicated to the proposition that all men are created equal.

Now we are engaged in a great civil war testing whether that nation, or any nation so conceived and so dedicated,

Figure 1. THE AYRES HANDWRITING SCALE 60 (RUSSELL SAGE FOUNDATION, PUBLISHER)

mentary stops, perhaps at the end of the *f*, at the end of the downward stroke in *o*, at the end of the upward stroke of *o*, at the end of the downward stroke in *x;* then you make the cross mark. You slow down at the turning points, perhaps the ends of loops in *f*, the end of the connecting stroke between *f* and *o*, the end of the connecting stroke between *o* and *x*, and on the turn in the downward stroke of *x*. In short, you organize the word. If you are a poor writer, you slouch over your work with almost no pause or slowing. Perhaps you slow down only at the end of the lower loop in *f* and the downward stroke in *o*, and pause only before the cross mark of the *x*. Having written *fox*, what is your verdict on your own handwriting?

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[4] Reed, H. B., *Psychology of Elementary School Subjects* (Ginn and Company, 1927), pp. 202, 211.

Probably your handwriting has already been measured on several occasions. Writing at a speed of sixty letters a minute, can you consistently reach Quality 60 on the *Ayres Scale?* The handwriting shown in Figure 1 is good, plain handwriting, which many children produce in the sixth grade. All studies show that to practice for still better handwriting than this is mostly a waste of time today. Why? Because good, plain handwriting is enough for an occasional letter or memorandum. If finer writing or more frequent writing is desired, it can be produced faster and better in every way by machine writing. Business men who require high quality or quantity writing buy machines to produce it. Why else did men invent — amid other possibilities — the typewriter? The words that you have so painfully organized are swiftly and precisely organized for you by this machine. Doubtless you already regret the absence from your own elementary education of this superior supplement for hands — the portable typewriter.

THE HUMAN HAND

At your command is a superior instrument — the human hand. The firm grasp of a friendly handshake illumines its social value. Yet this instrument is fitted also to manipulate the swifter, complicated writing tools invented to realize more completely its possibilities. Its finer points can hardly be too much admired.

Forearm and wrist carry power along a continuous straight line into your arched hand, to give a straight-ahead direction to such motions as typewriting. Through an X-ray machine you could observe the eight small bones of the wrist, constructed to permit unusual flexibility. Let your hand hang limp from the wrist, and shake it vigorously. Notice how flexible this wrist hinge is. Although the wrist should appear quiet when you typewrite, you are really using it as a splendid balancer for the power coming across from your forearm muscles to your fingers. The strong arm muscles at this elastic wrist, with its little bones so solidly laced, divide into tendons. These pull the three little bones of each finger or the two bones of a thumb. Glance at the three joints of your fingers that move so easily. Probably the middle joints will be fairly above the middle home keys on the typewriter keyboard. More than two dozen finely trained muscles can move these bones of the hand.

Beneath your palm are two sets of muscles that bend your fingers. Their tendons are free for each finger, allowing it to bend freely. These muscles are somewhat shorter than others of the hand, so that resting fingers naturally turn toward the palm — the start of the fine arch of the hand always used while typing. This also suggests why the swift snatch of your finger away from a typewriter key would be just a bit toward the palm of your hand. Think of these as your "inner" set of finger muscles.

The most important point in your study of the human hand is the definite way in which its muscles form two opposing teams. Think of the "inner" muscles as one team. Pull a finger against the top of your desk to feel these muscles. Think of the "outer" hand muscles as an opposing team. If you tighten all the muscles of your hand, what happens? Nothing happens in the way of movement. Each team of opposing muscles pulls against the other. All that you have are stiff, or wooden, fingers. Later you will be reminded time and again that a secret of fast typing is to relax one team while the other team works.

What are these "outer" muscles? Just beneath the back of your hand are the muscles that extend the fingers. These muscles throw the arched fingers at the keys when you start to type. Once you are typing, moreover, you will begin to wonder irritably at your ring finger. Its fate is soon told. The middle-finger and ring-finger muscles join at your wrist, but the back of each hand is also tied sideways by bands. Although these bands that bind the tendons together give your hand a wonderful firmness, they limit attempts to reach freely with the ring finger alone. Place your hand over the desk and press firmly down with your finger tips. To confirm its handicap, hold tightly to the table, especially with your little finger, while you reach the ring finger, or third finger, up or back Can you feel how closely the tendons of these fourth and third fingers are here bound by bands across the back of the hand? As a further contrast, note that your first and fourth fingers, and especially the thumb, benefit by having separate muscles.

Few Americans have written with finer appreciation of the human hand than has Gesell[5] of Yale. The remarkable independence of the thumb is, to this scientist, the outstanding triumph of the human hand. As you grasp some handy, rounded object, note how your thumb holds the object on one side in perfect opposition to the four fingers on the other. When you were a mere infant, however, your entire hand moved as one. The fingers were close and parallel. The action of the thumb was not independent and opposed to the fingers. Your thumb was then an ever-present nuisance, sometimes caught in the grip of the other fingers. Today your very fingers are independent in each separate joint, making possible innumerable, slight movements. Stretch out your hand, palm upward, and move all fingers, in order to note the easy flexibility of a quite perfected human hand — particularly of a thumb. As the thumb has its own muscles, both long and short, you send it almost any way you wish. To the thumb is assigned one of the most-used strokes in typewriting. The loosely bent thumb with its side strikes the space bar, which furnishes all spacing between words. You will also admire the quick twirl with which your right thumb controls the rush of paper into the typewriter.

Perhaps you remember how much stronger your right hand became as you entered your teens. Gesell[6] suggests that as the early language of savages was gesture signs with the right hand, even so your own right-handedness and your speech slowly developed together.

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[5] Gesell, A. L., "The Hand of the Race and of the Child," *The Normal Child and Primary Education* (Ginn and Company, 1912), Chapter VII, pp. 84–113.

[6] *Ibid.*

Yet a well-developed left hand gives you a balanced efficiency possible only with the use of both hands. You will find, for instance, that words typed alternately by fingers of opposite hands are usually fastest. You will plan, for instance, to use both hands at once while you change paper in the typewriter. Piano lessons have made it possible for fingers on balanced hands to play more than a thousand notes a minute. Thrum a piano, or do anything else at which you are clever, in order to rediscover for yourself the balance and efficiency of this extraordinary, ready-made instrument.

Through hundreds of thousands of years the hand, according to Gesell,[7] has become more and more slender, supple, and sensitive. Delicate nerve chains, that make your fingers and palm very, very sensitive, bind your hand to a marvelous human brain. Your fingers are four times more sensitive than your palm, with its thousands of tiny, spongy bulbs to help you feel. So tiny are these little nerve bulbs that only a microscope can reveal them. The pads on your finger tips are filled with so many tiny nerves that you feel the most delicate touch. Your finger tips can distinguish separate vibrations striking as fast as 1550 per second; they can feel minute distances or an extremely slight motion of a finger. No wonder the human hand is called a second eye.[8] It aids in gaining appreciation of things. It is handling, mischievous or otherwise, that has really shown you the modern world of objects and machinery. It is your own continued manipulating that is to weld your hands and typewriter into one working whole. Without the delicate nerves in your finger tips, in your finger muscles, and about your finger joints you would find it impossible to learn fast typewriting by "touch."

It is the human hand that has made possible painters, sculptors, surgeons, engineers, and mechanics. Hands have helped men the world over not only to develop arts and crafts and to invent machinery, but also to use hand tools and complicated machines. It is such hands that manipulate a modern typewriter at 100 words or more a minute.

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[7] Gesell, A. L., "The Hand of the Race and of the Child," *The Normal Child and Primary Education* (Ginn and Company, 1912), Chapter VII, pp. 84–113.

[8] *Ibid.*

Is this exceptional instrument of yours manicured and groomed as its value merits? Is it perhaps injured by nail biting or other abuse? Rounded manicuring will aid the delicate finger tips to touch and grip typewriter keys. In some way, even today, show your hands honor for the strange power they bring you.

BEYOND HANDS: THE MACHINE

Picture your own civilized self, if you can, as a mere savage back in the Stone Age when men had invented only clumsy tools out of bits of stone and wood. In such surroundings, you would necessarily cease to be your up-to-date self. Yet even in those hard days there were inventors at work, groping toward these modern days — men doing nothing but make tools for others. With the help of fire that melts and softens, bronze tools were invented; much later, tools of iron and even of steel. Power-driven machinery and factories are hardly two hundred years old. Already lighter metals, gasoline, electricity, and giant electric-power transmission are replacing the old iron steam engines that burned wasteful, dirty coal. Whereas five ancient Greeks may have worked a dozen slaves, you and any four other Americans are estimated to have some 150 mechanical slaves in modern machinery.[9]

In a sense, these machines are all extensions of the human body. Consider the overwhelming variety of tools which extend the power of human hands. They are so numerous as to baffle description. Perhaps two will suffice for illustration. In writing, the human hand has long been utilizing a pencil or a pen to trace its mark in lead or ink. More legible and more accurate, yet faster by far, are hands writing with modern machines, like the linotype, which casts lines for the printing presses, or the typewriter, which prints directly on paper. When trained fingers are placed on the modern typewriter, the human hand writes in a civilized way. Remember that you are living in an age of science and of new machines. Afford yourself a scientific attitude by weighing the newest changes. Make yourself efficient and up-to-date, wherever possible, by the use of available machines. Lift your writing above the rut of old-fashioned, slow-moving ways. Add the typewriter to your hands even as you add the telephone to your voice, the automobile to your feet, the movies to your eyes, the radio to your ears. Be civilized.

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[9] Beard, C. A., *Whither Mankind* (Longmans, Green and Company, 1928), pp. 27, 50.

INTELLIGENT BEHAVIOR

Intelligent behavior continues to effect many changes in American culture. A modern instance is the abandonment on a vast scale of handwriting for machine writing throughout the business and industries of the United States. For many women the typewriter is the passkey to the business world. According to the 1930 United States Census, more than half a million women typists speed the nation's business with their clear-cut typing. Amidst the welter of clerical duties in precise business offices, typing now ranks third. This is without mention of the elaborate billing, posting, and other bookkeeping machines built on the typewriter pattern. Commercial students are typing by the hundred thousand. Why do other students still cling to an outworn handwriting? Sooner or later an answer will be found in a hidden keyboard handicap which for threescore years has made learning to typewrite overdifficult.

Fresh from this all-inclusive conquest of business, however, the American typewriter at last is sweeping into other phases of everyday life. Newspapers, magazines, and books are written on the typewriter. Many personal letters are typed, still remaining friendly. Little primary children become fascinated with the portable typewriter despite difficulties with its keyboard. Written work of high-school and college youths increasingly arrives neatly typed for an instructor's grateful acceptance. Wherever handwriting, all too laborious longhand, might be used, the typewriter, once mastered, would be three to ten times as fast. We are becoming a nation of typists, if for no other reason than that intelligent behavior enforces savings in time. When all the rewards of increasing speed, ease, and legibility are considered, typing behavior seems obviously more intelligent than handwriting behavior. Learning to typewrite successfully is intelligent behavior in more ways than many mediocre typists appear yet to realize.

As you sit before your machine, can you breast the future and foresee the changes in your typing behavior? Good-natured telegraphers used to sit, ear-pricked toward the familiar click-clickity-click, with fingers pounding out telegrams upon the old "mill," or typewriter. Today they may watch an automatic teletypewriter. Today a simpler keyboard is possible. Today fewer typing instructors are set to give you an old-fashioned, quite lopsided "psychology" of learning to typewrite. Formerly, instructors might have neglected your individual personality and your independent, varied path through typing difficulties. The simpler psychology of animal training has too often dominated their views. These were naïve and lopsided, because all they represented was training finger muscles to be mechanical — a neat little set of "correct habits." Somehow these correct finger habits were to be sandwiched between reading the copy and manipulating the machine. If this were sufficient, then there could be no direct thought in the typewriting art,[10] just several senses, nerves, and finger muscles neatly bonded — just another chimpanzee response (if only the chimpanzee's hands were as clever as yours)! You had to drill your fingers on lines of perfect letters, while the instructor skipped off to direct his stenography class. Confronted with such empty notions, about all that former beginners could do was to sit down and regret their first glimpse of a typewriting class.

Mere repetition of finger motions, however, has never made even a poor typist. It is not denied that your deft finger muscles will play a lively part, at times dancing a most sprightly tap upon the keys. Neither is it denied that throat muscles play a most lively part when you recite admirably before any class. But both typewriting and reciting should be samples of intelligent behavior. Neither finger muscles nor vocal muscles should dominate either picture. The real domination arises in the co-operating human organism and is often felt as "insight." Central control is always the key to intelligent behavior.

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[10] Coryell, Relta, "Psychology of Learning to Typewrite," *Balance Sheet* (1930), Vol. XI, pp. 145–146.

DOUBLE-LANGUAGE ASPECT OF THINKING

All good newspaper reporters seek firsthand intimate details. This is also a prime move towards more scientific handling of a typewriter. For a civilized person about to experiment with a typewriter, there is no personal resource that approaches language. For a time, this greatest of human inventions will carry along your learning to type. There are ample words, as symbols, for everything which you are to do for typing mastery. At every step your classmates or your instructor or the authors of your manuals will give you countless suggestions about what to do to improve. Many students have already mastered operation of the typewriter, and their successful ways will be repeated to you. From answers to your questions, you will further absorb the ways of others. All this co-operative planning for your future mastery of the typewriter will be carried on by English symbols. Some of these will be new words chosen by the Gilbreths, engineers, to help you study motions. And this striking fact, sometimes overlooked by instructor and student, will emerge: Most of these detailed hints you will give yourself.

There is a certain sameness in all correct starts. Upon this essential sameness, your instructor rightly will insist. Much of the sameness you could discover for yourself by observing slow-motion films of expert typists. Their fast motions are easily slowed in each film. Otherwise your eyes could hardly follow them. These modern ways to improve your motions are called *motion studies*. This kind of study the Gilbreths have made famous. Yet the story of your typing progress, however much you have in common with your classmates and with the experts, should be increasingly a different story, if only because all other typists and their "mills" are also different.

Typing psychology is difficult, because you and the class and the instructor have to talk about relationships, sight unseen, far more than about finger muscles. It is absurd to interpret the complicated gains in typewriting skills as mere motor or muscular performances. It is absurd to consider a teacher's favorite typing drills as the open road to mastery. Typing skills emerge as the delicate balance of countless influences. The relationships are invisible and subtle. They are often labeled with strange, new names. Typing psychology is not for school children, but for self-reliant students already more or less civilized and hence intelligent. The student who emerges with quite remarkable skills from experimenting with motions thereby demonstrates his intelligent behavior. In popular everyday speech, "intelligent behavior" is attributed to "mind." Literally, the successful student is creating more "mind." It is a long story, for success is less a personal and more a social achievement. Mastery reflects an entire social world of classes, instructors, family, friends, and associates, within and without the college or school. Getting along with a typewriter is primarily a matter of any student's getting along with his typing group and with the local world of which he is a part. It is a matter, in short, of getting along with persons, since other persons set student attitudes, and such attitudes control the typing.[11]

Language has been invented, as you know, to help one person get along better with another person. It is for social adjustment, and it helps you and the other fellow to a working arrangement because it is a string of familiar word signs or signals to which both you and your friend react in quite the same way. You come closer to language by calling it *conversation*. At times your thinking may seem to be simply silent conversing with yourself. More likely, you merely echo the common thoughts of your associates. In any event, your thinking is checked and completed by others. It is built up by this interplay.

Suppose, for example, that you are requested to bring certain typing supplies from an unfamiliar storeroom. Your instructor tells you by a series of word signals how to get there and what to bring. To your instructor these directions mean the same thing that they mean to you. This social relationship, which enables you and the instructor to understand directions in the same way, takes you at once to the typing supplies without a long, distressing search. Or suppose that your typing class is to be taught how to insert paper into the machine. Your instructor describes to your class by a series of word signals better motions for inserting the paper. As he tells you, your instructor reacts to his directions in quite the same way that he expects each of you to react. This teacher-class relationship, which enables the class and the instructor to understand directions in the same way, takes you at once into motion study of paper insertion without overmuch distressed fumbling. Suppose, again, you are in trouble and ask a question. As you ask, you react to your question in quite the same way that your instructor reacts. This student-instructor relationship, which enables you and your guide to interpret your question in the same way, brings the instructor's help straight to your trouble. You are able to act upon his suggestion quite as this typing instructor would act, upon your classmate's hint quite as your comrade would act, upon the manual's direction quite as its authors would act — all with the aid of language. Is it clear that without other persons or without language you would have very little to go on? Without language, what need would there be for the typewriter and what incentive for your learning to typewrite? Is it clear that learning to typewrite is helped by the play of conversation both with other persons and with yourself? Mead[12] has clearly stressed this "double-language" theory of thinking.

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[11] See Powers, F. and Uhl, W. L., *Psychological Principles of Education* (D. Appleton-Century Company, Inc., 1933), pp. 167–201; and Gray, J. S., *Psychological Foundations of Education* (American Book Company, 1935), Chap. V.

Does this whirl into *social relationships* leave you dizzy? Really, the social facts are simple. Already your working vocabulary has grown well beyond ten thousand word symbols. You have, as guides to your motion study, your companions and teachers, your typing classmates and teacher, and the authors of your typing texts. Suppose all these persons and their printed or spoken words were suddenly wiped out. Suppose that by sudden affliction you were to lose all memory of language usage. What would be left of your "learning to typewrite"? Instead, by this doubled use of language, what your texts have to tell about typewriting will have quite the same effect whether you read the pages or whether the writers are present to tell you in person. If you can and do react to these pages in much the same way that the authors have already reacted, the psychological hints that follow will mean the same to you as to everybody concerned.

[12] Mead, G. H., "Thought, Symbols, and Language," *Source Book for Social Psychology*, Kimball Young, Editor (Alfred A. Knopf, 1927), pp. 341–346.

CHAPTER II

A BALANCED PERSONALITY BEFORE THE TYPEWRITER

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READING SUGGESTIONS

To the Student Typist: This chapter explains how typing success springs from your personality. It suggests how to improve this personality and how to meet typing trouble. It shows that your typing will improve, not by pounding in finger habits, but by your interest, your personal planning, and your co-operation with others.

To the Psychology Student: This chapter reviews mental hygiene, often the liveliest topic of interest in psychology. It can be applied to any academic subject. This review includes (*a*) the social background of personality, pages 18, 35 to 39, and 42 to 44; (*b*) usual defense reactions or dynamisms, pages 20 to 25; (*c*) personality inventories, pages 26 to 29; (*d*) case study, pages 29 to 31. Views are given of thinking as an expression of personality, pages 31 to 34; of learning as building attitudes instead of rigid habits, pages 39 to 44.

To the Typing Instructor: This chapter outlines the social setting of each typist through student eyes. Teacher interest follows particularly the trouble roles, pages 18 to 20; personality projects in typewriting, pages 39 to 44; and supervision, pages 35 to 38.

* * *

ROLES IN THE TYPEWRITING CLASS

1. *What is personality?* Unless and until a typing instructor knows how you feel about the roles you are to play within the typewriting class and outside it in your own social world, how can this instructor show much regard for your personality? You bring your feelings to the class. Just how do you feel, for instance, about the daily program planned to transform you into a skilled typist? This typing section to which you are assigned becomes one of your social groups. This typing group co-operates with you while you attempt the role that most quickly and easily achieves skilled operation of your typewriter. The roles you assume while typewriting

are a part of your personality. In your whole personality, in short, all the ways you feel, think, and do are bound up as one. Everything you and others feel, think, and do in groups is also part of American culture. What this culture means to a typing student is illumined when superior students write about their local community, family, friends, play centers, churches, and schools.[1]

2. *The initial crisis in learning to typewrite.* To bring you and a typewriter together for the first time really causes a crisis. The wide gap between your present inexperience and the future skills needed to operate a modern typewriter makes that inevitable. What is about to happen? You will attempt to operate this seemingly difficult machine with a vast excess of wasteful motion. In order to simplify this initial difficulty, you have the typing assignments, the instructor, and the example of classmates. In short, your first typing class is a social group carefully planned to help you solve your early struggles with a typewriter. Confusion will follow if you refuse to co-operate with this group.

In this first typewriting crisis, what personality will you assume? What role will you play? Will you take the successful way of the superior typing student? Or is it to be the troubled path of the inferior typing student, who must compromise his failure with alibis or daydreams, or the casting of blame, or "sour grapes"? The typing group to which you belong helps protect your personality from all such dodges and near-failures.

3. *The "trouble" roles in typewriting class.* A typing instructor's first interest in you is as a personality. Your early typing outputs take second rank. This is obvious since too much interference from personal handicaps blocks all typing improvement. The shortest path by which to advance your typing is to free your personality from any handicaps. Often typewriting errors do not just happen. They come in bunches on your typed sheets. Perhaps you ask, "Why do I do this?" Perhaps you glance about the class and see

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[1] Thrasher, F. M., "Social Attitudes of Superior Boys in an Interstitial Community," Kimball Young, Editor, *Social Attitudes* (Henry Holt and Company, 1931), pp. 236–264. See also Strayer, G. D., Frasier, G. W., and Armentrout, W. D., *Principles of Teaching* (American Book Company, 1936), Chap. I.

errors bunched on the sheets of a few other students. Such a bulk of errors is a personal matter. It results from underlying personal troubles. The typing errors and the speed losses are not the trouble, but merely its signs. Sometimes the errors may be part of a young typist's queer attempts to overcome personal trouble.

What are some of the "trouble" roles?

(*a*) There is the *tired* typist. So often this role is mistakenly called "laziness." Rest periods and relaxation are its antidotes. Perhaps this student is too tense. Perhaps his handicap is loss of sleep; perhaps simple lack of milk, leafy vegetables, fruits. Perhaps this student is too sensitive to a little physical defect hardly noticeable, such as a hidden infection, or glandular or other disorder that deadens "pep." It is for the doctor to suggest how to inject the extra energy needed to elevate this student in typewriting.

(*b*) There is the *backward* typist. As a learner, this youth seems always to be falling behind. Probably his other college classes are tagged with the same label. Clearly he has limitations, but with regular, patient handling, he can learn — slowly. Right now he is in a rut and looking particularly inert. What this young man needs is to be prodded, pushed, and praised to his limit.

(*c*) There is the *slow* typist. He may be a very clever youth, but a model of deliberation wherever he goes. On the playing field or in the college classroom, he gets so absorbed in careful details that he forgets time. His reminder should be a visible modern watch for time studies of his own slowness.

(*d*) There is the typist whose personality reflects some *emotional* upset. Irregular typing roles result in great variety. Foolish wastes of typing efficiency are the keynote. One common sign is inability to concentrate on typing practice. Perhaps this erratic typist is blocked by cumulative, petty troubles that keep his attention far from the keyboard, even though he is too alert to varied noises, voices, motions, and other distractions. Suppose this erratic typist, for instance, is still the spoiled son of an overprotected home. All his satisfactions are still at home, and he resents the insistent task of typewriting. Yet you can see that this classmate is quite unaware of his immature toying with the typewriter.

Naturally an erratic student typist runs to extremes. On the one hand, he may show too much emotion, be too happy, too talkative, too active. Perhaps this young man tells everybody what to do. Nothing seems to hold him down. Perhaps he transfers his antagonism toward some outside person to the typing instructor. He may attack by disorder, stubbornness, inexplicable cutting of typing practice. On the other hand, certain classmates may show too little feeling, withdraw from any typing effort — perhaps into daydreams, at least into indifference. A timid typist may be fearful that he is not equal to the demands of the instructor or of the typewriter.

Do you find yourself uncomfortably close to any of these roles? All personal upsets that leave an odd and erratic personality before the typewriter make for typing disability quite regardless of the teaching. Of the real facts behind these "trouble" roles, the students concerned are probably unaware. At any rate all such roles in a typing class are "trouble" indicators, and the players are just normal typists [2] temporarily astray.

ATTITUDES TOWARD THE REALITY OF TYPING DIFFICULTIES

Your own social world surrounds you. Whatever you experience affects your attitudes, and your attitudes affect your ability as a typist. If a defeat comes, you may be depressed; if a success comes, you may be full of enthusiasm. Canvass your realities and face them squarely. Life must be lived with other persons who rarely know how to co-operate. Their interests are hardly your interests. Do you know how best to handle the frictions that arise with your companions, instructors, and even with parents? Should you continue to co-operate when dislike becomes mutual? Should you accept their different ways or even the leadership of your equals? It is evident that they sometimes dodge responsibility with ready alibis, yet interfere if you assume responsibility. Older persons, circumstances, and college or school requirements likewise continually interfere. Otherwise reality would be easier.[3]

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[2] Mateer, Florence, *Just Normal Children* (D. Appleton-Century Company, Inc., 1929).

[3] Burnham, W. H., *The Normal Mind* (D. Appleton-Century Company, Inc., 1924), pp. 241–244.

1. *Facing the difficulties of typewriting.* All this is far from hinting that you should boldly face a difficulty in every waking hour. What a strain! Naturally you find suitable excuses for occasional oversights, missteps, and slips. Naturally you take pleasure in ambitions and daydreams, identify yourself with the heroes and heroines of exciting fiction or of the movies, and turn to sports indoors and outdoors. Yet, whenever a typewriting crisis really presses, do you resolutely face it? The healthful way to face a typing difficulty is this: hold your feelings in suspense and think out a plan.

There are many advantages in treating a typing difficulty like any other problem. Your typing classmates and instructor may help you break this problem into details, discover whatever is behind it and in front of it — in short, search for the way out. Then a plan should appear. Often you have only to act on your decision in order to transform a typing difficulty into an exhilarating success. Hollingworth[4] tells you that all learning starts with annoyance and is won when you reduce the irritant. Perhaps you have already discovered that this aggressive facing of assignments is the simplest secret of your college and earlier school success.

2. *Emotional dodging of typewriting troubles.* Early in life you learned to attack or to avoid trouble. It is one thing to compromise or even to run away from typing troubles as part of a definite plan. It is quite another matter to follow your feelings into failures that fool even yourself.

When you dodge a bit of unpleasant typewriting practice, do you know from what you flee or to what you go?[5] Perhaps you really are running away from unpleasant social or home experiences and not from the typewriting. Perhaps you really are running away from an unhappy clash with a chum or a boorish classmate or the strict brusqueness of an unpopular instructor. Some students run from the distasteful wherever it may be — in the playing field they run from defeat, in the classroom from failure, at home from the lawn mower. It may be that you have discovered an absorbing interest in another line than typewriting. Do you understand the obscure reason for your flight from typewriting practice? Or are you aware only of your dislike or indifference? Are you dodging practice because you just feel that way? Is it possible that you are afraid you will not be equal to fast typewriting? Such feelings automatically lower your efficiency. It is ironical that a superior typing student may suffer this inferiority feeling at first. The really backward typing student is more likely to be blandly unaware of his outstanding weakness. In either case typewriting progress may be destroyed. The annoyance that attends a typing difficulty remains until the problem is either successfully detoured or else thought out to its answer. Thinking is hard work. It is far easier to fly off into some emotional compromise. Several of these everyday classroom substitutes for real thinking are listed.

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[4] Hollingworth, H. L., "Effect and Affect in Learning," *Psychological Review*, Vol. XXXVII (1931), pp. 153–160.

[5] Chamberlain, H. E., *School Clinics* Papers, First International Congress on Mental Hygiene (American Foundation for Mental Hygiene, 1930), pp. 12–13.

(*a*) *Rationalizing.* Many typing students, whom you will readily recognize, follow their feelings and dodge or otherwise mishandle difficulties in whatever way they want to; then they invent "reasons" as excuses or alibis to justify themselves. Plausible excuses make typing-classroom slips easier to endure. Yet if clever excuses keep piling up, surprisingly little volume is accomplished. A common alibi is to "project" the unpleasant blame on circumstances or on another person. Perhaps the typewriter is blamed or the manual or the instructor. This throwing of personal annoyance on other shoulders is, as you will surely agree, camouflage.

(*b*) *Identifying.* Another emotional compromise with typing failure is to identify yourself with some successful person. In this way a youth identifies himself with an athletic hero scornful of typing drills, or a girl identifies herself with the most popular college girl who happens to have slight use for any kind of practice. In college and school groups it is virtually necessary to live partly in the lives of other students and of instructors. It is often pleasant to make their roles a substitute way out of difficult typewriting. The reverse of this identifying is to "transfer" unpleasant feelings. Even if an identity is merely felt between the typing instructor, for instance, and a hated teacher or oversevere parent, all co-operation in typewriting may automatically cease. Often neither party is aware of this classroom "transfer" of feelings.

(*c*) *Daydreaming*. All daydreams are pleasant. Whatever you wish, you win. On occasions when typewriting becomes unpleasant, isn't it surprising that more students do not find a pleasant answer in daydreams? Even though you fail at typewriting, in daydreams you see yourself the salaried expert whose fingers dance lightly over the keys. More likely this flight from typing troubles is into a dream of livelier hue. You star on the athletic field or shine at the dance or whirl in a high-powered car to theater or restaurant. At the very worst, any person responsible for unpleasantness deeply regrets your martyred suffering! These ambitious flights and inventions may stimulate your typewriting. When daydreams become excessive, however, astonishingly few typing difficulties are ever faced. Even daydreams cannot compete with the successful working out of clever typewriting.

(*d*) *Regressing*. Another form of flight away from occasional typing trouble leads back to more pleasant experiences in the past. Sometimes you see another student who tries to live back in younger school or home days. Possibly as a child this student typist won whatever he wanted by temper outbursts. Now, in the face of a typing irritant, he returns to this childish way. He gets irritable, even angry, in an immature outburst. Perhaps he tears and crumples the typed sheets like a destructive youngster. Perhaps he flares into jealousy of a more successful fellow typist. Possibly this classmate met his childhood troubles by running home for sympathy. Now he turns to the instructor or like adults for sympathy instead of facing his own typing problem. Probably he is unaware that he is behaving below his age level. He feels that his mature attack on the typewriter has failed and quite naturally falls back on earlier successes. The rub is that these earlier methods no longer work. Yet this looking backward for comfort is often a help. At least the sting of a present rebuff in the typewriting class is lightened by the recall of an earlier success.

(*e*) *Compensating*. Any defeat in a typewriting class may seem an invitation to seek success elsewhere. Some new success will smother the typing defeat. Lack of typing progress can be compensated by success in other studies or by social success in student extracurricular affairs. Such compensations are often dramatic because they are driven by feelings. But sometimes the compensation overruns itself, though of this exaggeration you or any other student is usually unaware. The exaggeration may lie in a plunge into other studies or into a student activity or a downtown job with a zeal out of all proportion to a typewriting failure. Or a most outspoken role may be assumed in the typing class. Always belittling the work of typewriting, for instance, is commonly called "sour grapes." A too-easy optimism that bravely feels all typing-class troubles will unscramble into a happy ending is another cloak for weakness. This sort of student compensation has been ascribed to Pollyanna. The "dateless" girl may compensate by bizarre dress and odd behavior in the typing workroom. The unpopular classmate may be too much the good fellow, too boisterous in his appreciation of humor, too loud in his backslapping, too free with his help. Compensation is a straightforward substitute for feeling "inferior." Only in excess does it interfere with typewriting. Unsolved typing troubles then have a way of piling up until it is no longer possible to compensate further.

Any typing irritant counts less; the way you feel about it counts more. All students are driven by attitudes. Park[6] says a wish gives each attitude its kick. At every turn in the typewriting class emotional compromises help smooth going. The absurdity arises when a student typist fails to realize that he is feeling and not thinking. Daily he deludes himself. Daily the emotional jams grow as he dodges assignments. The above compromises in excess become shoddy substitutes for student planning and doing. Their excessive use destroys typewriting progress.

3. *Maturer attitudes in typewriting students.* It is a sign of maturity to face squarely at the right time whatever difficulty may arise in typewriting. Maturity means the ability to make decisions while standing on an independent footing. It takes firm, friendly detach-

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[6] Park, R. E., in Kimball Young, *op. cit.*, "Human Nature, Attitudes, and the Mores" (Henry Holt and Company, 1931), p. 31.

ment from excessive control by older adults, instructors, or parents. Yet dynamite often seems the only stuff that will loosen maturing youth from their domination. How absurd if you older students are indulgently given fussy directions at the sacrifice of hard thinking over your typing problems! How stupid it seems to withhold responsibility! Certainly superior students can assume considerable responsibility for their own typing progress. Such mature and self-reliant roles clash with the dependent role of an irresponsible youth. Under freedom, individual paths to typewriting success can be openly pursued. Freedom is safe as long as you and your fellow students are interested in worth-while typing tasks.[7–8]

SOCIAL SUCCESS IN YOUR TYPING GROUP

1. *Your "looking-glass" self reflects your typing group.* The moment you enter a typewriting class, you should become a part of a united or co-operating group. Just as a rowing crew, to win, must hold its group self-respect, so you, to improve your typing, must take note of the attitudes of your classmates toward typewriting advancement. You build up fictions concerning your class or concerning yourself as a typist. Whence do these beliefs about your "self" come? They are largely the ideas which your student associates and typing instructor seem to have. Can you hold in this class a footing that your instructor and companions will recognize? Can you keep your balance as an equal in this group, despite all the likes and dislikes of the persons therein? This gives you status. Cultivate their attitudes toward yourself, since in their recognition and friendship you will be mirrored as a friendly, recognized person. Indeed, it is their very recognition that makes you a distinct personality. You are what Cooley[9] has named the "looking-glass" self. To any casual stranger, you are of little consequence. To an outsider, until he knows you, you are just one of a crowd. But to your typing-class friends you can be an attractive personality. Perhaps you supply more than your quota of humor to the group.

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[7] Burnham, W. H., *op. cit.*, pp. 205–229.

[8] See also Powers, F. F. and Uhl, W. L., *Psychological Principles of Education* (D. Appleton-Century Company, Inc., 1933), pp. 412–507.

[9] Cooley, C. H., *Life and the Student* (Alfred A. Knopf, 1927), pp. 194–198.

Perhaps you supply more than your share of "pep" and helpful leadership. Perhaps like many other student typists you are really a companion. Others are mere followers. A few may be rejected by the group. Isn't there something in typewriting wherein you can excel rather than follow?

Personal diaries[10] help to show the feelings with which you color typing-class life. It is not unlikely that typing-class records of the future will be partly in diary form. How do you feel about these new social contacts within your present typing group? As long as you avoid other typists and play a colorless role, your personality remains colorless. Do you still feel unhappy, shy, perhaps indifferent, or even antagonistic? Then time is lost in thawing out or reconciling antagonism before you can share in the rising class progress. If, on the contrary, you are happy as an equal in your typing group, this makes all typewriting a likeable group affair. You are helped to a personal success by sharing experiences. You reap dividends from this mutual give-and-take while making plans together. In this way typewriting skills are passed along from group to group. It is startling how much the finished (or unfinished) typist mirrors some typing group.

2. *Check lists of personality roles that you play.* Doubtless you are ready to agree that attractive personality is an asset both in the typewriting class and in your approaching career. Naturally, few prospective employers will fail to weigh your personality. In the typewriting class, too, a well-poised personality before the typewriter not infrequently marks the superior learner. Why? Correct, fast typewriting is impossible for you at this moment, yet an equipment of fast typing motions is to mark the close of your training. Obviously, considerable changes must occur in yourself. What, other than your personality, is to sustain your typing practice until you at last balance yourself with steady ease during fast typewriting? Your personality is a balance between your assets and your non-assets. It is vital that your typing assets be increased until you are changed into a successful typist.

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[10] Burgess, E. G., "The Cultural Approach to the Study of Personality," *Mental Hygiene,* Vol. XIV (1930), pp. 307–325.

Is personality still a somewhat vague notion to you? Then there are stencil check lists to stress for you its chief features. These have been detailed by Bernreuter[11] into pointed questions, which you can digest in a very few minutes. Perhaps there is no shorter approach to some insight into what a well-poised typist's personality should be than to check "yes" and "no" for yourself. The 125 sentences presented might even be absorbed as a typewriting exercise. It is interesting to type and answer these straightforward questions, then score your answers. This could show several directions in which you might be different from most typing students. These are paired as: more *aggressive* or more *submissive;* more *introverted* (turned inward toward personal thoughts and feelings) or more *extroverted* (turned toward the outside world of persons, typewriters, action); and more *self-sufficient* or more *dependent* on other persons. After all, the great value of these questions is in calling to your attention the social details that surround typewriting in social groups.

If you enjoy these brief check lists as a help in understanding your personality, you may wish to experiment further. Have you ever sought to estimate the degree of your present happiness?[12–13] In first tryouts of such a test, to be sure, both "happy" and "unhappy" students seemed to agree upon "liking to typewrite." Happiness seems more a matter of making satisfactory impressions on other persons. The "unhappy" students seem to feel self-conscious, sensitive, timid, and inadequate. For sheer *sociableness,* check the Cleeton list.[14–16] For social cleverness, match yourself against the Moss examination.[17] There are either the Thurstone[18] or the Woodworth-House[19] list, aimed at the unstable student, and the advanced Willoughby[20] list of sixty statements to estimate *emotional maturity* of the college typist.

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[11] Bernreuter, R. G., "The Personality Inventory," sample set and scoring stencils, Stanford University Press, Stanford University, California.

[12] Watson, Goodwin, "Happiness among Adult Students of Education," *Journal of Educational Psychology,* Vol. XXI (1930), pp. 108–109; incomplete check list, pp. 80–81. Sample set, the author, Teachers College, Columbia University, N. Y.

[13] Cason, Hulsey, "Annoyance Test," sample set, C. H. Stoelting Co., Chicago.

[14] Schoen, Max, *Human Nature* (Harper and Brothers, 1930), pp. 454–459.

[15] Gilliland, A. R. and Burke, R. S., "A Measurement of Sociability," *Journal of Applied Psychology,* Vol. X (1926), pp. 315–326.

[16] See also McCormick, M. J., "Scale for Measuring Social Adequacy," sample set, C. H. Stoelting Co. Chicago.

[17] Moss, F. A., Hunt, T., Omwake, K. T., and Ronning, M. M., "Social Intelligence Test," sample set, George Washington University, Washington, D. C.

[18] Thurstone, L. L. and Thurstone, T. C., "The Personality Schedule," sample set, University of Chicago Press, Chicago.

Why not scan, in any event, what is perhaps the shortest of all personality-rating scales?[21] It presents to you five possible answers for each searching question:

(1) How do your appearance and manner affect others?
Answer: avoided; tolerated; unnoticed; well liked; sought by others.

(2) Do you need constant prodding, or do you go ahead with your work without being told?
Answer: need much prodding in doing ordinary assignments; need occasional prodding; do ordinary assignments of own accord; complete suggested supplementary work; seek and set for self additional tasks.

(3) Do you get others to do what you wish?
Answer: probably unable to lead; satisfied to have others take lead; sometimes lead in minor affairs; sometimes lead in important affairs; marked ability to lead and make things go.

(4) How do you control your emotions?
Answer: too easily moved to anger or depression; tend to be overemotional; usually well balanced; well balanced; unusual balance and self-control.

(5) Have you a program with definite purposes in terms of which you distribute your time and energy?
Answer: aimless trifler; aim just to "get by"; have vaguely formed purposes; direct energies effectively with fairly definite program; engrossed in realizing definite purposes and plans.

Your answers to all such check lists may be compared with your reputation among your fellow typists by a parallel device sometimes used in high-school classes. This is called "Guess Who?" For example, as the following and other items are dictated, the entire class types in names of students who fit each description:[22]

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[19] House, S. D., "A Mental Hygiene Inventory," *Archives of Psychology*, No. 88 (Columbia University, 1927).

[20] Willoughby, R. R., "A Scale of Emotional Maturity" (starred items), *Journal of Social Psychology*, Vol. III (1932), pp. 23–34.

[21] "Personal Methods," *The Educational Record Supplement* (American Council on Education, Subcommittee on Personality Measurement, 1928), No. 8, pp. 58–59.

(1) Who is always trying to crack jokes and make others laugh in class?
(2) Who is always making fun of other people?
(3) Who is always teasing someone younger or smaller than himself?
(4) Who is always pushing or shoving or tripping up other people?
(5) Who is always trying to get attention in class?
(6) Who never recites or demonstrates in class unless he is called on to do so?
(7) Who is always daydreaming in class?
(8) Who is always playing with something else during the lesson so that he does not keep abreast of the class?
(9) Who is very restless, always moving around, asking someone where the lesson is, and the like?
(10) Who is the person who has no friends (or only one friend) and is always going off by himself?
(11) Who is always blaming other people for his failures?
(12) Who is always staying out of class for minor illnesses or complaints?

Such identifications by "Guess Who?" suggest what personality assets some less successful student typists still lack.

3. *Adding personality assets in typewriting class.* Personality may be hard to describe by such blanket words as *tact* or *resourcefulness* or *self-control.* Personality is, however, quickly felt and even demanded in business. You may find it interesting to compare your choices of such assets with the ideas of employed women.[23] Imagine that you are about to sally forth with your added typing skills and embark boldly on a career. What personal assets do you consider vital? Do you place *ability to follow directions* first, as did women stenographers? Or would you give first place to *carefulness in details*, as did women office clerks? Or would you place *responsibleness* ahead of all other personal assets, as did the secretaries and office managers? If you believe that as a commercial typist

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[22] Symonds, P. M. and Jackson, C. E., "An Adjustment Survey," *Journal of Educational Research*, Vol. XXI (1930), pp. 321–330.

[23] Manson, G. E., "Occupational Interests and Personality Requirements of Women in Business and the Professions," *Michigan Business Studies*, Vol. III, No. 3 (University of Michigan, 1931), pp. 281–409.

manual dexterity would be a wonderful help, for instance, notice that you and the stenographers simply do not agree. Table I carries these seven top estimates by thousands of employed women.

TABLE I. Order of Seven Traits Most Essential to Occupational Success as Estimated by Employed Women (From Manson)[24]

Trait	Stenographers	Private Secretaries	Office Clerks	Office Managers	All Occupations *
Ability to follow directions	1	3	3	6	6
Carefulness in details	2	2	1	3	4
Responsibleness	3	1	2	1	2
Courtesy	4	5	4	5	3
Speed	5				
Self-confidence	6			7	
Pleasing appearance	7	6			5
Systematic habits			5	7	
Alertness		7			
Initiative		4		4	
Self-control			7		
Knowledge in special field					7
Tact		7			
Ability to handle and deal fairly with people			5	2	1

* 13,752 employed women from every occupation.

Suppose that from some forty desirable traits already collected by Charters[25] from actual secretaries at work, you chose *resourcefulness* as closely allied to *initiative* and *originality*. What makes a resourceful stenographer? This indefinite trait must first be translated into definite acts. Thus, a resourceful stenographer in action uses his head to supply words and phrases missing from the dictation without waiting to be told; he types answers to routine letters and looks up information needed to answer new inquiries; he collects and files magazine and newspaper items of live interest to the management and thus anticipates what is wanted; he keeps the unfinished-business file cleared; he cross-indexes the files to keep them usable; he notices the things his employer dislikes to do and relieves him of these minor annoyances. Doing all this without being told, it is easy to agree, is being resourceful.

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[24] Manson, G. E., "Occupational Interests and Personality Requirements of Women in Business and the Professions," *Michigan Business Studies*, Vol. III, No. 3 (University of Michigan, 1931), pp. 281–409.

[25] Charters, W. W. and Whitley, I. B., *Analysis of Secretarial Duties and Traits* (Williams and Wilkins Company, 1924).

Fifteen projects designed to bring out this personality trait in action are suggested by Wakefield.[26] What would happen if you and your associates would discuss and applaud resourcefulness in handling projects in the typing class? Do you find resourcefulness in the building of word and sentence lists for drills on difficult combinations of keyboard reaches? It would lie in the number of typed sheets that are used as sources for the list. Do you find resourcefulness in the making of original tables and curves to show the class scores on Blackstone typing tests? in improving spacing after punctuation, immediately following group discussion? in rewriting wretchedly arranged copy for the college or school newspaper in attractive form, with a self-discovery of what proofreading marks show? or after half the class has alternated in watching the other half at work, in reporting observations in the form of a short letter? After a semester of such projects, the resourcefulness of one typing group, measured by twenty-five practical questions, jumped from a 131-point to a 174-point score.[27] Do you realize the high value of this little experiment as a concrete example of how to develop personality within the typing group? The trait is displayed in action and discussed in lively fashion by the student audience. It actually becomes a role played in the typing group.

4. *Social contacts to balance typing roles.* All successful student activities known as extracurricular act as balancers in helping a student typist to build poised social personality. Outside social contacts have a place in any complete scheme for typewriting im-

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[26] Wakefield, Alice, "A Technique for the Development of Resourcefulness through Typewriting," Monographs in Education, *Research Studies in Commercial Education*, Vol. IV, First Series, No. 11 (University of Iowa, 1929), pp. 19–33.

[27] *Ibid.*

provement. Book [28] has reminded you of the curious ups and downs in daily typing scores, of "lazy" days, of typewriting lapses quite beyond your control. Not infrequently you will need to look outside the classroom to understand these "bad" and "good" days. Likewise, typing improvement may be sustained by the success of your social contacts outside the class. If you care to estimate your leisure-time sociableness, check your recreations for a week against the Lehman play quiz; [29–30] then count the number wherein others took part with you. The proportion quickly reveals the extent of your social contacts.

Suppose you write each day a time diary of the things you do and of the size and kind of groups in which you do them. With such time diaries Hayes [31] discovers that those who take little part in student affairs seem to fall back on commercial amusements or perhaps they substitute reading or music or they study and practice more or they have more home duties or work for wages.

Do you observe that your fellow typists who strike a happy moderation in their social recreations seem best adjusted to typewriting? The resulting personality contrasts favorably with that of the student who plays either too much or too little. There is little value in being a mere playboy to all and sundry. Indeed, too much indulgence in play increases the chance of college or school failure.[32–33] Those students who share only a few play activities may be wanting in personal attractiveness but are not necessarily odd.[34] In truth, it is not the number of social contacts that counts but the kind, because typing practice is part and parcel of your present living, just as the typing classroom is part of your local world.

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[28] Book, W. F., *The Psychology of Skill with Special Reference to Its Acquisition in Typewriting*, Studies in Psychology, Vol. I (University of Montana, 1908), pp. 130–134.

[29] Lehman, H. C. and Witty, P. A., *The Psychology of Play Activities* (A. S. Barnes and Company, 1927), Play Quiz, pp. 37–40.

[30] Witty, P. A., *A Study of Deviates in Versatility and Sociability of Play Interest*, Contributions to Education, No. 470 (Teachers College, Columbia University, 1931), Play Quiz, pp. 53–56.

[31] Hayes, W. J., *Some Factors Influencing Participation in Voluntary School Group Activities: A Case Study of One High School*, Contributions to Education, No. 419 (Teachers College, Columbia University, 1930).

[32] Moffett, M'Ledge, *The Social Background and Activities of Teachers College Students*, Contributions to Education, No. 375 (Teachers College, Columbia University, 1929).

[33] Stroke, S. M. and Cline, W. F., "The Avocations of 100 College Freshmen," *Journal of Applied Psychology*, Vol. XIII (1929), pp. 257–265.

[34] Witty, P. A., *op. cit.*

5. *Conforming with typing-class conventions.* Are you out of line somehow in the typing class? Is it becoming a hardship to conform with the everyday requirements for "standard" typists and future secretaries? It is usually taken for granted that you will follow the expected ways. If you venture to try a new and different way, you may disturb your associates to an extent that startles you.

What do you gain by staying in line, by doing whatever others expect you to do? You gain a great deal. You bring your typewriting up to the usual standard set by your typing instructor, and this level may be high, just as it may be low. You model your motions on the best typewriting that you have an opportunity to watch. After all, the likenesses between expert typists are more important than their differences. The Gilbreths[35] in their celebrated motion studies have dealt with the likenesses between typewriting experts, because they find that all champions use much the same methods. By making yourself like other typists, you cease to be odd. You escape interference at the hands of classmates, instructors, employers. You escape feeling inferior. On the contrary, you feel secure.

Is there anything to gain by doing the unexpected? You catch an open hint by watching American fashions. To follow the latest fashion is to do the expected thing in a somewhat novel, different way. Your slang is a little newer and more racy. Your dress is a little shorter or longer. Your trousers are a little baggier or tighter. Your car is a little more streamlined and snappy. You are different but not too different. As a clever person, you conform where essential and for the rest follow your personal preferences.

6. *Being "different" by means of the formula: "Be yourself."* Certainly you do not think for a moment that champions like Tangora and Hossfield conform with the motions of the usual typist. It is true that there is a certain sameness about typing groundwork for

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[35] Gilbreth, F. B. and Gilbreth, L. M., *Motion Study for the Handicapped* (George Routledge and Sons, 1920), pp. 15–16.

the beginner. Yet mastery of this groundwork should free you to try new ways. Having attained the usual class standard, suppose you go further. Suppose you invent your own individual style of typewriting to fit your own fingers and personal energy and body rhythms. This is more than supposing. Typewriting by the better students within the same class, Butsch[36] tells you, is so surprisingly different that, if you did not know, your first guess would be that they had worked under different instructors and in different groups.

Since any new way may be so at odds with the class view as to be annoying, any typewriting-class stage may well be set to tolerate experiments. Whenever a real difficulty is felt in typewriting, ideas can be pieced together until a usable idea literally pops out. This idea may be peculiarly suited. A clever instructor watches for it. Its way can be demonstrated to the group. This gives thinking a threefold check by each student, the class, and the instructor. Their co-operation helps to insure each discovery, however slight. All travel the pathway of posture and motion studies.

Being "different" in these new ways, peculiarly suited to yourself, is strangely rare. Yet it holds all the fun of following your own typing hobby. It holds all the possibility of being distinctive and interesting to others. Before you may indulge in your individuality, you and your personality must sufficiently reflect the interests and ideals of the class to enable you to maintain your social contacts and conform to the typing-class conventions. In an inspired little book, Dimnet[37] has urged that you find your own interest vein by wide exploring. Search for whatever you really like about typewriting, even if this is simply typing social letters, an artistic arrangement for reports, easier motions, or your choice of supplementary assignments. Follow it while you enjoy it. You will be surprised at the way you chance upon fascinating personal discoveries while you are following the shortest formula for successful thinking, as stated by Dimnet and by American thinkers like Emerson. It is simply this: "Be Yourself."[38]

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[36] Butsch, R. L. C., "An Experimental Study of Progress in Typewriting," Master's Thesis (University of Chicago, 1927).

[37] Dimnet, A. E., *The Art of Thinking* (Simon and Schuster, 1929).

[38] *Ibid.*

ATTITUDES TOWARD THE AUTHORITY OF TYPING TEACHER AND FUTURE EMPLOYER

1. *Co-operating with supervisors in business and industry.* Imagine five girls seated much as five typists would be seated. In place of a typewriter there are coils, armatures, contact springs, insulators, fixtures. These girls are assembling telephone relays in the Hawthorne Plant of the Western Electric Company. During two years the output of these test-room girls has been rising. Yet they are not urged or speeded up and scarcely notice their own high speed. If there is any magic in modern psychology, it is applied in this test room. If you knew the key to the remarkable improvement of these girls, would it help your typewriting progress? It is mostly a matter of personal attitude, of the way each girl feels about the work assigned.

The major part of the feeling reflected in each excellent performance is in the attitude toward the supervisor.[39–40] Friendliness and confidence are established to such an extent that practically no supervision is required. Is this your attitude toward your typing instructor? The new type of supervisor, as pictured,[41] listens rather than gives futile orders, listens rather than talks, thus gaining insight into the mind of the worker and recognizing distortions of his thinking. Behind such supervision or teaching is a conversational approach. The operator confidently talks out his troubles. The listener, or instructor, is silent or simply follows along in a conversational, friendly way. In this way operators are relieved of the nervous tension under which they previously worked. They are freer, happier, more contented.

2. *Co-operating with instructor and student guides in the typewriting class.* Is your classroom stage set likewise with all that is essential for typewriting progress, so that you feel guidance slightly if at all? If the typing assignments are consistent, there is no incentive to

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[39] Pennock, G. A., "Industrial Research at Hawthorne," *Personnel Journal*, Vol. I (1930), pp. 296–313.

[40] Putnam, M. L., "Improving Employe Relations," *Personnel Journal*, Vol. VIII (1930), pp. 314–325.

[41] Mayo, Elton, "Changing Methods in Industry," *Personnel Journal*, Vol. VIII (1930), pp. 326–332.

be an erratic typist. If there are no irregular routine and waste of time, these can hardly be reflected in waste of office and personal time later. Members of a group torn by personal frictions would probably continue to co-operate miserably with office workers later. A group that is forever told what to do and dominated by its instructor would remain dependent on office supervisors; its members would be the reverse of self-helpful. Systematic orderliness is what makes your typing group efficient, and this very regularity is reflected in reliable personalities. The best results are obtained when you co-operate with the typing teacher to chart the study plans and check the study progress,[42] and when student leaders cease to act as immature despots asserting their own superiority. These student leaders help and check when needed. In this well-prepared social situation (created by the typing instructor) feelings of inferiority and striving toward superiority over others tend to cease; but self-reliance and, above all, fellow feeling and the wish to co-operate increase.[43]

The typing class is not only an elevator to a business-office standing, but also a sieve, as Sorokin[44] pictures it, to winnow the less fit from the more fit. You will not be long in the class before you discover whether or not this sifting is realized more by guidance, as already pictured, than by failure of credit or promotion. In the enjoyable haven of the modern typewriting room your class no longer "marches in chain-gang formation from the beginning to the end of a term, dragging with it many who derive little or no profit from its operations, because they are either too far behind or too far ahead."[45] Instead, you are advancing through your typing contracts or budgets or progress charts at your own rate. Your associates also plan, practice, and check their typing, so that the instructor is free to observe the motions of any student who needs help. This is the exception principle in scientific management.

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[42] Maguire, E. R., *The Group-Study Plan* (Charles Scribner's Sons, 1928).

[43] Sief, L., "Individual Psychology and the Psychosis," *American Journal of Psychiatry*, Vol. VII (1928), pp. 639–647.

[44] Sorokin, P. A., *Social Mobility* (Harper and Brothers, 1927), pp. 188–191.

[45] Learned, W. S., *Realism in American Education*, The 1932 Inglis Lecture (Harvard University Press, 1932), p. 36.

The stage is set, and the typing group improves. The instructor gives time to the aiding of all exceptions.

3. *Changing unhappy relations with a typing instructor.* If handling in mass elsewhere in college or school brings several of your classmates into the typing class feeling useless, suspicious, bored, or superior, you observe an instance of unhappy relations with authority.[46] Perhaps the pressure of too much failure or of previous bossing has left them feeling defiant and stubborn. Perhaps this pressure has caused a feeling of inferiority and made timid dependence upon instructors seem the easier way.

Now students themselves often help another student improve his unhappy relations with an instructor. Yet your interest is more likely to be that of a silent spectator. It will help you to co-operate and may help you to face some personal problem of your own if you analyze the way a clever typing instructor reduces the personality troubles of a class. This will be doubly interesting because it helps to explain the widely popular topic of "psychoanalysis." If you have any contact with today's psychology, you appreciate that its best-known feature is the analysis of "nervous" cases by Doctor Freud of Vienna.

Start then with the unhappy feelings of certain students. As an interested spectator, follow the changes in these students over three stages. Remember that if your class is made up of successful student typists, all are above these stages and no such strictness should be needed.

(1) At the outset the instructor transfers these unhappy feelings to himself. Freud calls this *emotional transference.* This instructor takes the center of the stage. Like an actor, he concentrates attention on himself. He becomes a strict but just authority. He insists on a slow, calm atmosphere. Instead of lagging or dashing through typing work at all sorts of foolish tempos, every student follows the even tempo of the instructor's dictation. Each discovers incidentally for himself a correct rhythm in which to approach the keyboard. Only this student-instructor relation is permitted. Each works at his typewriter as if no one were in the room except him-

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[46] Symonds, P. M. and Jackson, C. E., *op. cit.*

self and the instructor. The latter speaks to one at a time, answers one question at a time. He never blames, but simply explains. Freud calls this the *interpretation.* If unco-operative feelings, such as an outburst of irritation, interfere with the classwork, the instructor merely makes this distressing result clear. In this way an instructor calmly restates and then interprets to such students their individual personality difficulties when before a typewriter.

(2) The next desirable stage is to break up this dependence on the instructor. Accordingly, the instructor shifts from the strict and active to a more passive role. Success in solving typing problems now carries its own reward; hence punishments and rewards are greatly reduced. Soon these students accept this new attitude. Each seems satisfied to conduct himself, wanting neither to boss nor to be bossed. At this point you observe whether these typing students are yet able to carry on as the instructor has interpreted — to go ahead on their own initiative. Freud calls this the *working through* of the interpretation. This new freedom is difficult for the instructor and the typing class when a student refuses to do what is expected or seems eager to please no one but himself. Yet there is no other way to try out his new mettle.

(3) A final stage, however, is left. The instructor begins to allow himself natural liberties; for instance, he may show displeasure on occasion. Here is a test of a student's ability to remain calm in irritating situations. For a while this instructor interprets that he, too, is human, that it is necessary to adjust to other people's temporary indispositions. A touch of humor, too, is always a useful mental antidote.[47] Thus the gap is bridged from this typing instructor to other less tolerant authority in the school, the home, or the future job.

This brief résumé of the classroom remedy for an unfortunate attitude[48] further illustrates, by its contrast with normal freedom, the key value of a friendly, co-operative student-instructor relationship in promoting your studies of typing errors and motions.

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[47] Burnham, W. H., *op. cit.*, pp. 399–401.

[48] This concludes a very brief résumé of an illustration of the analytic approach by Rosetta Hurwitz in "Another Aspect of Mental Hygiene in the Classroom," *Mental Hygiene*, Vol. XV (1931), pp. 17–33.

TREATING TROUBLE INDICATORS IN THE TYPEWRITING CLASS

Typing misbehavior then mirrors ineffective attitudes and personal handicaps. A student who is having trouble is as conspicuous as a careless, erratic automobile driver on a public highway.[49] Do you wish to listen in on an interview with a prospective typing instructor?

> "*Are you familiar with the typewriter? Can you operate it efficiently?*
>
> "Oh, I can type," says this cadet teacher. "I don't think I'll have any trouble."
>
> "Does a student's paper mean anything to you besides so many words and so many mistakes? Will you know what to do when he makes this kind of mistake or that kind of mistake? Does a paper present to you the personality of the student who typed it?"

It is this last question which staggers the startled prospect. Hamack [50] finds such personality liabilities as "carelessness," "lack of neatness," and "lack of confidence" reflected more or less in the typewritten sheets turned in. Thus, a neat-appearing young man was turning in typed sheets which were decidedly not neat. A quick check revealed anything but neatness in his daily living. His orderly classroom appearance was due solely to the trim uniform required in the naval corps of which the student was a member. It is a rare typist who does not typewrite as he feels. Whenever he feels that his practice is interesting and important, for instance, his typing changes surprisingly. Whenever his attitude interferes with normal typing, it is necessary to evolve a plan for removing this handicap. If the plan fails, a new plan is tried. If the plan works, the typing errors or other signs of trouble disappear, of course. This procedure may take a few minutes or it may take an entire semester.

1. *Discovering an attitude.* Just how do you feel about a definite typing difficulty? Your own story, as you talk out your trouble, very likely mirrors your attitude. The story told while the typing instructor listens differs with the depth of your confidence in this

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[49] Hamack, F. H., "Personality in Typewriting," *Balance Sheet*, Vol. X (1928), pp. 50–52.

[50] *Ibid.*

instructor. This is called *rapport.* If the instructor is set to blame or penalize misbehavior, you will naturally conceal your real feelings. Moreover, you are not yet completely aware of your own feelings. The aim of such a story is to help you see your own attitudes and understand how you have moved to where you are: [51]

(*a*) *Attitude during this conversation.* Do you enter into the spirit of the occasion? Are you self-conscious, restless, flighty, boastful, indifferent, or apathetic?

(*b*) *Attitude toward typing misbehavior.* What have you to say about your typing difficulties?

(*c*) *Attitude toward school.* Why do you believe that you get along well or poorly in college or school? in the typing class? Does your report compare well with the reports from all instructors? Do you like college or school? Do you like typewriting? If not, why not? What is your feeling toward your other instructors? What are your scholastic ambitions?

(*d*) *Attitude toward recreation and other interests.* Do you prefer recreation by yourself or with other students? What types of active or passive recreation do you follow? Are you a leader? What other interests have you? What work do you do at home? Do you earn any money? If so, what do you do with it?

(*e*) *Attitude toward companions.* How do you get along with companions? Do you feel that they plague you too much? Do you think your companions are good or bad? Do you prefer companions of the same sex or of the opposite sex, and why? Who are your special chums? What do they talk about?

(*f*) *Attitude toward family situation.* Are you underprivileged? Are you teased much at home? Do you believe that you are controlled too much at home? Do you like better your father or your mother, and why? Do you feel that you, or another son or daughter, are the favorite? What are your feelings towards your brothers and your sisters? Are there other relatives whom you particularly dislike or like?

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[51] Division on Prevention of Delinquency, National Committee for Mental Hygiene, "Psychiatric Examination of a Child," *Mental Hygiene*, Vol. X (1926), pp. 300–306. See also Caswell, H. L. and Campbell, D. S., *Curriculum Development* (American Book Company, 1935), p. 127.

(*g*) *Attitude toward body.* What, if any, are your complaints? What are your interests and habits in personal hygiene?

(*h*) *Dream life.* Do you daydream? What about? Do you dream about typewriting class or studies? Does your dream life suggest emotional disturbance of any kind?

(*i*) *Fears and emotional conflicts.* Of what are you afraid? Are there signs of any feeling of inferiority or compensations? Is there conflict over love affairs? What is your attitude toward other difficult situations or persons important in your own world?

2. *Discovering the handicap that interferes with successful typewriting.* This approach continues until the underlying interference with typing is uncovered.[52] The faulty condition may soon be obvious or it may be so hidden that only a *case study* will uncover the real situation. If the classroom stage is cleverly set, any failure somehow reflects the background of school time, home time, or leisure time.

Features of the home background can be decisive in a typing failure. At least your own story is incomplete without your parents' version. Do your parents appear to appreciate the following general possibility in your relationship with themselves? Parents may not understand the feelings of older sons and daughters. A gradual weaning from parental control properly starts in early. If the home is still too indulgent, it makes the typing class at school seem unsatisfying. During adolescence, a friendly release from parental domination becomes a pressing affair. Only in this way can the young man or girl learn self-direction. If adolescents submit to dependence, they carry this weak and immature role over into the typing class. If they rebel, their resentment may extend to the typing-class authority. Little energy is left for typewriting when a student's personality is threatened by excessive home conflicts.[53]

Features of the college and school background should be at hand in your cumulative student record.[54] More and more today's records show important facts beyond mere lists of artificial course "credits" — facts such as health history, definite educational measurements, distinctive interests and achievements, outstanding personality traits.

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[52] See Symonds, P. M., "Group Methods for Conducting a Mental Hygiene Survey of High School Pupils," *School and Society*, Vol. XXXII (1930), pp. 501–506.

[53] Chassell, J. O., "The Experience Variables Record" (University of Rochester School of Medicine, 1928).

[54] Wood, B. D. and Clark, E. L., "Cumulative Record Form." Sample set, World Book Company, Yonkers-on-Hudson.

Can you, as a student, answer searching personal questions,[55] keeping your typewriting improvement in the foreground?

(1) What are your major college or school interests, your best and poorest courses?

(2) What are your course work difficulties?

(3) What are your personal difficulties — the burdens of worry over sickness at home, family finances, racial prejudices, other upsets, such as social difficulties?

(4) What are your major extracurricular interests?

(5) What are your employment and financial plans while in college or school?

(6) What are your vocational plans?

(7) Have you any health worries or handicaps?

(8) How may your living conditions reflect your typing progress?

(9) In the light of your chief interests and handicaps, what changes do you recommend to tone up your typwriting?

3. *Moving "mental mountains" in order to succeed with typewriting.* Underlying typing difficulties are unique in the sense that each is a part of whatever total situation happens to confront you at the moment. You are an important part of this situation. Think of your attitude as a definite set in your muscles to type a certain way. Think of your attitude as the pause, or "get ready," just before your actual motion. At the moment something or other occurs to upset the set of your typing muscles. In each case of upset some incorrect attitude in your muscles conflicts with good typewriting. Errors pile up. Fatigue and speed losses begin. The details vary with each situation. Try to find out what could possibly divert your muscles from their proper motions. What is happening in the classroom? What happened just before this class? How are you contributing to the error? Into what position are you slumped? What kind of motions

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[55] Reeder, C. W., "Personal Work in the College of Commerce and Administration of the Ohio State University," *Proceedings of the National Education Association* (1930), Vol. LXVIII, pp. 277–279.

are you making? Try to recover an attitude that will start the correct motions. Then your typing attitude will harmonize once more with better typing. In your typing studies, in which you deliberately set your muscles to make better motions, a few simple suggestions from Muenzinger [56] may help you in each case to a better attitude.

(*a*) *Change of setting and self-help.* In fact, you are so much a part of any situation in which you find yourself that its setting is changed whenever your attitude changes. If you are discouraged to the point of wishing to withdraw from typewriting, for example, the setting is changed when you realize that you can face this difficulty. This is why your persistence will resolve some typing problems.

(*b*) *Counterbalancing attitudes.* Offset the thought of trouble which disturbs your typing practice. If you are unable to concentrate because of family troubles, for example, repeat to yourself that your success at college or at school is necessary to help your family. If the little affairs of the family fill your mind to the exclusion of your typewriting, break away from all that. After all, you must live your own life. Ask yourself, "What is more important than these affairs?" If you are worried and distressed over a disagreement with some classmate or instructor, remember that other students have lived through like "tragedies" and carried on. Oddly, it is your resistance to this worry or resentment which often makes it persist. Say, "I cannot let myself be influenced by this." Revise your social contacts and keep up whatever friendships still seem valuable to you.

(*c*) *Substituting other behavior.* Discover what new typing behavior will serve you better. If loud talking, unattractive dressing, and extreme shyness, for example, interfere with your tryouts in a business office, try more agreeable ways. Even after you gain insight into your difficulty, unfortunate ways — already automatic — of talking, dressing, working, worrying, or of meeting people may be slow to disappear.

(*d*) *Appeals.* Timely appeals may add new feelings and reverse an incorrect attitude, but it is safer to ignore any appeal to fear of the consequences of typing failure.

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[56] Muenzinger, K. F. and Muenzinger, F. W., "The Psychology of Readjustment," *Mental Hygiene,* Vol. XIII (1929), pp. 250–262.

(*e*) *Definiteness of attack and planning ahead.* Know exactly what you are after. If you are disappointed by the snobbishness of classmates, for example, and change your aim to success in commercial typewriting, then keep this change of intention clear-cut. Be concrete about trouble. Type out on a sheet of paper the concrete details of just what happened in the library or at the dance. Work out counteracting thoughts and action in definite sentences. Spend a definite time in asking yourself questions about the difficulty. Assume a tentative attack before you begin to typewrite.

In brief, a typing difficulty is to be faced and planned against, whether it inheres in fellow students, family, instructor, typewriter, or yourself.

INTERPRETATIVE SUMMARY

Fast, correct typing depends, to an extent too seldom realized, on a typist's poise. Only when supported by a finely balanced body can correct typing motions come forth. Today it is known that this fine body balance is inseparable from the whole personality of the typist. All students who advance into vocational typing will find that a well-balanced personality speeds office output and is vital for personal success in business offices.

Typing is a social art invented to give a more fluent means of written expression. Rapidly typed messages help to control other persons even at a distance. Typewriting is thus a part of living, just as learning to typewrite is a part of student life. Modern living happens in social groups. Correct motions supplied by a poised personality before the typewriter, accordingly, are efficiently developed in a social group, the typewriting class, organized solely to secure these ends.

Personal troubles may be mental mountains blocking the way of typing improvement. It is a rare typist who does not work as he feels. These feelings closely mirror his college and school, home, and leisure life. Unhappy or antagonistic feelings must be removed before the typist can share in typing progress. By checking lists of personality assets, a personal deficiency may be found and balanced by the right social contacts. The student typist is warned in detail against the many emotional evasions by which difficulties in learning to typewrite are usually dodged. An excess of these evasions injures the personality balance and may develop into "trouble" roles which lead to a typing failure. The healthful way to reduce irritants is to hold down these feelings and think out plans.

By co-operation in meeting the conventions of the typing class, an individual student escapes interference from his instructor or his classmates and later from employers, and he acquires no feeling of inferiority such as colors a "trouble" role. The real gain from being "different" develops naturally in unmarked experimenting by the superior student until a distinctive style of typing becomes his own creative achievement.

CHAPTER III

TYPEWRITING INCENTIVES

* * *

READING SUGGESTIONS

To the Student Typist: If you are already interested in typewriting for itself, read chiefly of social incentives by praise, rewards, school clubs, and contests, pages 47 to 52; class stunts, pages 55 and 56; the value of warming up, page 67; and of knowing your results, pages 67 and 68. If you plan to make typing your vocation, add pages 56 to 65.

To the Psychology Student: The great stress in modern psychology upon motivation brings you to a concrete illustration of social incentives, pages 47 to 52; and to "knowledge of results" as the prime incentive, pages 67 and 68. Read also concerning vocational interest inventories, pages 56 to 64 and 66. A minor point is the use of warming up to inhibit an interfering attitude, page 67.

To the Typing Instructor: While you may wish to skim the account of grade-school typing, pages 52 to 54, the special points in this chapter are the use of mass contests to bring "knowledge of results," page 67; of assignments to sustain interest, pages 65 and 66; and of vocational advisement, pages 56 to 65.

* * *

"When you find out what you want," contributes the Sphinx,[1] "I hope you'll one and all get what you want, provided you care to have that kind of want."

The Sphinx is pointing to whatever you want as a disturbing lack in your present world. In order to close with this restless feeling, you willingly face trouble and practice to win the desired result. Whatever you want becomes a sustaining drive that nicely heightens the tone of your muscles. Freeman's [2] precise measurements reveal clearly that an incentive, such as money, influences the spread of activity in your muscles. Over-encouragement, on the one hand, and excitement, on the other hand, probably increase your activity but lower your typing output. Discouragement probably lessens both activity and typing output. Within these limits, felt incentives seem to add potency that attracts successful typing motions. Happy combinations of incentives bring outstanding gains in typewriting.

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[1] From *The Motives of Men*, by G. A. Coe, copyright, 1928, by Charles Scribner's Sons. Chapter VI, pp. 36–55.

[2] Freeman, G. L., "The Facilitative and Inhibitory Effects of Muscular Tension in Mental Work," *Psychological Bulletin* (1931), Vol. XXVIII, pp. 687–688.

Up-and-down differences in power of a single incentive are astonishing. Think for a moment of turtles instead of typists. Casteel[3] considers that the pain of an electric shock is a real turtle incentive to avoid certain food boxes. This single incentive made some turtles so nervous and wild that they were useless. Others took to shock gradually. Some grew sulky and refused to come near. Some quickly scurried away but seemed eager to return.

Naturally primitive incentives like hunger or electric shock are more energetic than social motives. This contrast is neatly drawn in Leuba's[4] experiment with youthful work at a standstill. A chocolate bar as a reward increased effort 52%, whereas the final gain, with social rivalry, praise, and recognition added, rose no higher than 65%. Typewriting, however, is a social art. The drives to typing achievement follow complex social incentives.

SOCIAL INCENTIVES

1. *Recognition and social success as typing incentives.* What social incentives do you students recognize? Laird[5] says that the best-liked ones are praise before parents or the public, friendly conferences with the instructor, encouragement from parents, being excused from certain work, and being in love. Certainly students feel that reprimands, ridicule, sarcasm, low grades, and extra assignments actually lower their improvement. Praise, accordingly, is a powerful typing

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[3] Casteel, D. B., "The Discriminative Ability of the Painted Turtle," *Journal of Animal Behavior* (1911), Vol. I, pp. 1–28.

[4] Leuba, C. J., "A Preliminary Experiment to Quantify an Incentive and Its Effects," *Journal of Abnormal and Social Psychology* (1930), Vol. XXV, pp. 275–288.

[5] Laird, D. A., "How the Student (High School, College) Responds to Different Incentives to Work," *Pedagogical Seminary* (1923), Vol. XXX, pp. 358–370. See also Powers, F. F. and Uhl, W. L., *Psychological Principles of Education* (D. Appleton-Century Company, Inc., 1933), Chapter IV.

incentive. Even though you know this, it will be hard to restrain a pleased smile while listening to praise from your instructor or classmate. Fortunately, in the better typing class there is usually something at which each student typist can excel. Any superior performance of which your typing group is aware may afford this outstanding incentive known as social success. Its potency may be greater if recognition by praise is added.

As an illustration of the results of praise *versus* reproof, take an English test. An English class is divided by Gilchrist[6] into two equal sections: the one praised, the second reproved. In a subsequent English test the praised section gains 79%, the rebuked section actually deteriorates. When one group is praised, another blamed, and a third ignored, it appears that improvement will be most, less, least. The ignoring of good work is worse than open reproof. More than on any other incentive, your typing instructor may rely on recognition of special achievements.[7] This incentive is systematized not only by the regular posting of superior scores under a student's name, but even by buttons, printed ribbons, certificates, and other recognized emblems. The net result of successful typing motions thus heightens stimulation.

2. *Typewriting programs by departmental clubs.* Suppose typing students describe their most pleasant and unpleasant experiences during a given time. Fifty students have written out all the pleasant and unpleasant occurrences of a given three weeks.[8] What is pleasant? Pleasant feelings go with social contacts, visits, "dates," social correspondence. Such incentives point to the brilliant uses of special clubs. In a student club you and other typists having commercial interests can gather and give your typing troubles a common airing. In the sessions of this commercial club, new inventions, such as noiseless library portables, slot-machine typing for a nickel, telephoning by typewriters, or radio typing can hold

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[6] Gilchrist, E. P., "The Extent to which Praise and Blame Affect a Pupil's Work," *School and Society* (1916), Vol. IV, pp. 872–874.

[7] Weersing, F. J., *Reorganization of Commercial Education in Public High Schools* (South-Western Publishing Company, 1929), p. 37.

[8] Jersild, A., "A Note on the Pleasures and Unpleasures of College Men and Women," *Journal of Abnormal and Social Psychology* (1931), Vol. XXVI, pp. 91–93.

the stage. Readings, songs, instrumental music can surround such playlets as *The Trailers of Errors*. The more dramatic success stories of private secretaries can be rehearsed. Here you can ride the crest of a vocational incentive. Have you perhaps chosen a private secretary's role as your elevator to a business success? Do you and the secretaries already enjoy the same interests in persons and things and doings? All this and more can be built around typing as a practical, common hobby. Whenever a subject lags, at least in high-school work, it is almost axiomatic that a spontaneous extracurricular club can rekindle interest. Doesn't it seem ridiculous that in a survey of 160 typing instructors elsewhere, only 4 instructors appear to have such a commercial club available for their students?[9] With a popular teacher sponsor well in the background, informal club discussions of typewriting are an absorbing offset to academic routine.[10]

3. *The class audience for student demonstrations.* It further follows that fellow typists by their mere presence seem to smooth and facilitate control of typing movements. On occasion they also provide an "audience" as a helpful incentive. Suppose, instead of practicing on a typewriter, students practice holding a flexible counter on a revolving target. These movements, even as those used in typewriting, require a fine co-ordination between eye and hand. Travis[11] finds that four fifths of his students could cling more surely to the revolving target under the eyes of an audience. When you or other students informally demonstrate typing motions, a similar incentive is provided for the demonstrator and a needed rest period for the class audience.

4. *Typewriting rivalries between classmates.* Further incentives flow from the rivalry natural in any group. The competitions into which you may enter have their counterpart in half of all typewriting classes.[12] To the fishing enthusiast, for instance, there can be

[9] Weersing, *op. cit.*

[10] Roberts, A. C. and Draper, E. M., *Extra-Class and Intramural Activities in High Schools* (D. C. Heath and Company, 1928), "Commercial Clubs," pp. 357–358.

[11] Travis, L. E., "The Effect of a Small Audience upon Eye-Hand Co-ordination," *Journal of Abnormal and Social Psychology* (1925), Vol. XX, pp. 142–146.

[12] Weersing, *op. cit.*

very lively competition in rapidly turning a fishline reel. Triplett[13] has decided that fish reels are speeded by such incentives as sight of the movements of the pacemakers and the obvious interest in higher speed. Similarly, a faster typist may serve as pacemaker for a slower classmate. If your class breaks into rival groups, the resulting incentive seems to work better when such groups are about equal in average ability. Such group rivalries can be stepped up to almost any intensity by clever discussion and publicity. Yet at best, Allport[14] warns you, this sort of rivalry increases speed rather than precision and widens the differences between students. You may know some student typists who keenly dislike the strain of competition.

Despite all the ballyhoo when two class teams, as in high school, are pitted one against the other, such competition usually leads to less typing improvement than a close rivalry between two students who possess fairly similar abilities. For example, if two less able students are pitted together, their mutual gains may seem triumphant. Yet in competition with a superior typist, their gains would appear as discouraging trifles. If you ever try competing with a student of about equal prowess, you appreciate how readily this changes into a race against your own records. This is a real incentive for keeping close records of lines typed and speed-test scores, and these are second in importance only to actual typing. If you are skeptical of competing in pairs, examine Sims's[15] comparisons of three college classes. Each student in the first of these classes is paired with another of like ability, keeps his own score, and battles to surpass his own record and that of his partner. The second class is split into competing sides. Each side is always aware of its scores and is egged on to best the other. There is no competition in the third class. In practice at substituting numbers for letters, the first class improved 34%, the others only 8% to 14%. Which class reflects the stronger incentive? Obviously self-competition, in pairs, seems the more efficient way.

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[13] Triplett, N. B., "The Dynamogenic Factors in Pace Making and Competition," *American Journal of Psychology* (1897), Vol. IX, pp. 507–533.

[14] Allport, F. H., "The Influence of a Group upon Association and Thought," *Journal of Experimental Psychology* (1920), Vol. III, pp. 159–182.

[15] Sims, V. M., "The Relative Influence of Two Types of Motivation on Improvement," *Journal of Educational Psychology* (1928), Vol. XIX, pp. 480–484.

5. *The elimination* versus *the mass contest.* Despite enthusiasm over mass contests between entire high-school classes in home typing rooms, the real thrill of high-school typing belongs to the handful of winners picked by the state typewriting contests. About one half of all high schools are represented in these district and state elimination contests. It would exceed passing interest to know how student typists feel toward this rapid elevation of the few fastest novices. The topmost cream of the school novice championship race is no longer skimmed by speeds much under 65 net words a minute. What might be called milestones in the life of a school typing champion are, at the start, somewhat as follows. In the larger high school, group competition soon stirs up interclass contests. As the tests lengthen, monthly awards may be offered. Increasingly, the actual contest is then left to representative student typists. The two fastest operators from each of several classes compete in an interclass contest, with a prize for the best. This superior typist is next launched upon a career which, after suitable skirmishes to wipe out aspirants from other local schools, honors his own high school with the fastest fifteen-minute time in the state, or even beyond state boundaries. The real incentive power, however, lies in the earlier interclass contests when shared by many students who eagerly watched their net speeds on all written tests of the month.[16]

The favored swing, accordingly, is toward contests between whole class groups. A mass contest is held solely in the home classrooms. When the typing classes of an entire region compete, a list of all scores immediately shows any student exactly where he stands as a typist and just how his class compares with other schools. Several months later he can again check his personal progress with the typing improvement of even distant neighbors. All typing students thereby face the reality of their typing results, whereas state elimination contests elevate only the few fastest operators.[17] That is

[16] Dubbs, C. R., "The Beginning Class in Typing," *Balance Sheet* (1928), Vol. X, pp. 9–10.

[17] Soderberg, I. W., "Class Contests in Typewriting," *Balance Sheet* (1927), Vol. VIII, p. 11.

why three fourths of 141 high schools tell Slinker[18] of their favoring sentiment for regional typing contests that include all students taking typewriting.

TYPING AS ITS OWN INCENTIVE

1. *Portable typewriters for grade children.* The parade of typewriting contests and paired rivalries that has just passed, if you glanced closely, throws the power of its incentives in support of concrete records. All in all, typewriting is interesting by far in its own right. Concrete typing records build up enthusiasm by proving this to be a successful interest. Even though students may be herded into required *Typewriting,* irrespective of any whys, wherefores, or interests, the first usable successes with the precise modern typewriter probably launch enthusiastic feelings.

Before you admit a personal interest in typewriting for itself, try to recall the old handwriting days in your grade school. Try to relive the thrill which a typewriter on your desk would then have stirred. How could any picture of a typewriter as its own incentive be more clear-cut? You may feel a slight reminiscent pang to read of nearly 2000 portable machines lent to children in the first six grades of schools in a dozen cities. What more than 6000 children did with typewriters in one or two years, in a study by Wood and Freeman,[19] serves as a national demonstration that portable typewriters can be incentives to the study of almost any school subject. The lure of each brightly colored machine for these eager youngsters has reflected quite overwhelming applause by their teachers. Two teachers in every three agree that the typewriter puts pleasurableness into teaching.

What do 90 to 130 informal minutes with a typewriter each week achieve in children? These 6000 youngsters were able to typewrite with the speed of handwriting, with some 3% to 6% of error, which was sheer gain, since their handwriting kept its usual form. The thrill of their new machines has actually quickened their interest in prosaic spelling and also in words and their uses, in number work, and in geography. In careful achievement tests these typewriting children gain 7% of a grade over other pupils. Teachers say it is easier for a youngster to think with a typewriter. The portable helps his writing form and his self-expression. In the first grades, the usual youngster, spurred by this fascinating new "toy," wrote over 3000 words. Other first-grade pupils, not so indulged, averaged 500 words. In all the "typewriting" grades, the children by hand and by machine not only turned out more written work, but also added more original writing by wide margins.[20]

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[18] Slinker, C. D., "A Survey of Commercial Contests," Monographs in Education, First Series, No. 9, *Research Studies in Commercial Education* (University of Iowa, 1928), Vol. III, pp. 57–59.

[19] Wood, B. D. and Freeman, F. N., *An Experimental Study of the Educational Influences of the Typewriter in the Elementary School Classroom* (The Macmillan Company, 1932), pp. 117–127, 180–184.

Typing on the portable typewriter is treated as an incentive for other school subjects throughout the elementary grades. Unexpected effects spring from the many practical uses immediately discovered by the children. These practical interests arise in writing class newspapers, school magazines, projects, labels, spelling lists, reports on reading, stories, and letters. Older pupils even add vague vocational longings for typing as a help to later income or adult success. Little primary youngsters appear fascinated with sheer mechanical features of the gayly colored portables. So rich are these varied interests that Haefner[21] is able to suggest the portable typewriter as a promising substitute for the pencil. Into this informal school atmosphere, so vital to incentives, compromises with systematic typing instruction necessarily intrude. A list of typing standards rises from a light touch, with one hand dominant, in kindergarten typing to the second-grade standard of employing the first finger on each hand correctly and using another finger for remaining keys. For those in the fourth grade or above, the rising standards require the use of the left hand for each carriage return, of the thumb for spacing and for margin stops, as well as the correct use of most of the fingers on both hands. Even with the present keyboard, occasional pupils lay the basis for a real "touch" method.[22] Difficulties that handicap the typing interests of children center in the manipulating of the keyboard.[23] A more systematic use of the typewriter by children thus depends on their introduction to a simplified keyboard with easy stroking of many words entirely in the home row.

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[20] *Ibid.*

[21] Haefner, Ralph, *The Typewriter in the Primary and Intermediate Grades* (The Macmillan Company, 1932), pp. 42–43, 54–89, 316–323.

2. *Personal typewriting in high school and college.* If portable typewriters click for young children in such thrilling fashion when used to imprint newspapers, reports, plays, booklets, letters, cards, and labels, then their expanding use at high-school and college levels may easily exceed present expectations. Indeed, personal typewriting has already become a notable incentive for a year or part of a year in a typing classroom. Abetted by the time saving from a period of training, reduced by short-cut methods and the possibility of a less awkward, faster keyboard, the typewriter should enter into the everyday life of a majority of students. These newer economies in personal typewriting, indeed, will hasten its early mastery amid general and tryout courses for pupils of junior high schools. Once mastered, a typewriter is seldom abandoned, for it helps to express thoughts much more rapidly than the laborious pen and pencil can. The clear-cut imprint of the modern typewriter should raise the tone of the vast volume of written work in schools and colleges. The noiseless, portable typewriter in study rooms and libraries would quicken the pace of reference work. Lively, intensely stimulating practice material will appear in abundance, drawn from the actual needs of students.*

As the supply of typists and typewriters for business and industry approaches the saturation point, it is likely that the relative size of enrollments for vocational and general clerical typing in the commercial department and for personal typewriting will be reversed.

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[22] Rowland, R. S., *An Experiment in the Teaching of Typewriting to Fifth- and Sixth-Grade Pupils* (University of Nebraska, 1929).

[23] Haefner, *op. cit.*

* See Merrick, N. L., Bown, R. F., and Dvorak, A., *My Typewriter and I* (American Book Company, 1937) for junior high-school applications. See also Merrick, N. L., "Touch Typing for Children," *Educational Administration and Supervision*, March, 1935, pp. 226–229; and Bown, R. F., "Non-Vocational Typewriting in Junior High School," *Junior-Senior High School Clearing House*, Sept., 1935, pp. 35–38.

By way of illustration, young men who start in independent business with little capital or who are employed, perhaps, as traveling salesmen or as junior executives will block out their written work on personal typewriters. As a part of social life an increasing number of young women will type their personal correspondence or their club work. In fact, the rapid mastery and more fluent self-expression possible with a simplified keyboard will offer personal typewriting as a vastly increased field for typing expansion. The introduction of a portable typewriter as a part of automobile equipment and the supplementary use of slot-machine typing are not improbable guesses as to what will happen as the art of typing grows general. Parallel events will stimulate everyday usage. Typing instruction by radio television is easily conceivable. Even now teletypewriter exchanges make it possible for anyone who can operate a typewriter to communicate instantly by wire with any other subscriber around the corner or across the continent. A typewritten record appears from both receiving and sending machines. When typing becomes so stimulating in itself, special incentives will be needed less and less.

3. *Typewriting-class stunts.* There are striking "stunts" with which to increase your enthusiasm for typewriting, such as the skillful use of typewriters to print bar diagrams and progress charts,[24] or, a step further, to sketch actual drawings.[25] It may be fascinating to design on your typed reports a silhouette border of sailing ships, pretty girls, small, saucy soldiers, or a football hero. A light pencil outline is drawn and filled in to form a solid mass with some stroke like *x* or *z* or *w* or $, closely spaced. For illustrations of this attractive art work examine the designs by Mix[26] that include DeWitt Clinton's early railroad train and Independence Hall, Philadelphia, or the design of a peacock typed by Pengilly.[27] The "Parade of the Wooden Soldiers," as strummed by Boston University typists, becomes a dramatic incident. The heavy, slow

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[24] Chamberlin, J. E., "Typing Graphs," *Balance Sheet* (1929), Vol. XI, pp. 70–77.

[25] Compare the typed drawings and designs of school children in Wood and Freeman, *op. cit.*, pp. 144–147, 168.

[26] Mix, Floyd, "Typewriting Art," *Popular Mechanics Magazine* (1931), Vol. LVI, p. 1023.

[27] Pengilly, J. J., "Peacock Design," *Gregg Writer* (1923), Vol. XXV, p. 365.

group resounds like the foundation booming of the bass drum, while the fast typists bring rapid-fire, snare-drum effects.[28] All this staccato rhythm is heightened by heavy backing paper bulging slightly in the typewriters. This parade, scored for three batteries of typewriters, is given on page 57.

A feeling for the right rhythm may be the unexpected by-product of such occasional "stunts." Typing technique, too, must be up-to-the-minute. Music has its place for short periods. Typing rhythms should feel right. Grace and skill go hand in hand, as Ogden[29] tells you in his unusual and adequate description. You feel your way through skillful acts. You discard clumsy motions again and again until you suddenly feel a new ease. Your typing motions then fit together as smoothly as a flowing musical melody. Hands and wrists are built on graceful lines to move in satisfying rhythms. There is this artistic incentive in all expert typewriting, quite apart from artistic arrangements of the typed page.

VOCATIONAL INCENTIVES

1. *Vocational interests are changeable.* It may be but a step from lively stunts and everyday usage, whether for school and college work or personal letters and records, to typing interest as a direct aid to your earning power. Interest in a life career can become a powerful incentive. It leads to advanced typewriting work for the expert mastery of practical typing skills. It would be absurd not to pause and discover whether this interest already exists in you. Even when absent, this interest may be developed. In general, the younger the student typist, the more changeable are his vocational interests. By way of illustration, Kansas schoolgirls assume such interests along with added age. More than twice as many favor life as stenographers and typists at 16 as at 10.[30] This shifting

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[28] Smith, H. H., "A Model Demonstration of 'Typing to Music,'" *American Shorthand Teacher* (1928), Vol. IX, pp. 143–148.

[29] Ogden, R. M., "The Esthetic Nature of Perception" and "The Acquisition of Skill," *Psychology and Education* (Harcourt, Brace and Company, 1926), 130–146.

[30] Lehman, H. C. and Witty, P. A., "The Constancy of Vocational Interests," *Personnel Journal* (1929), Vol. VIII, pp. 253–265. See also Stevens, W. M., *Financial Organization and Administration* (American Book Company, 1934), p. 5.

TABLE II

PARADE OF THE WOODEN SOLDIERS [31]

First Group:	*Beats*
FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR	3
FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR	3
FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR	3
FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR	3
FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR	3
FOR FOR FOR FOR FOR FOR FOR FOR	3
FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR	3
FOR FOR FOR FOR FOR FOR	3
FOR FOR FOR FOR FOR FOR	3
FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR	3
FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR	3
FOR FOR FOR FOR FOR FOR FOR FOR	3
FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR	3
FOR FOR FOR FOR FOR FOR FOR FOR FOU FOR	3
FOR FOR FOR FOR FOR FOR dkdkdkdkdkdkdkdkdkdkdkdkdkdkd	

Second Group:	*Faster than First Group*
thisthisthisthisthisthisthisthisthisthisthisthisthisthis	3
thisthisthisthisthisthisthisthisthisthisthisthis	
Element Element Element Element Element Element Element	
FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR	3
Element Element Element Element Element Element Element	
Element Element Element Element	3
Element Element Element Element Element Element Element	
Element Element Element Element Element Element Element	
FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR	3
Element Element Element Element Element Element Element	
Element Element Element Element	3
Element Element Element Element Element Element Element	
Element Element Element Element Element	3
Element Element Element dkdkdkdkdkdkdkdkdkdkdkdkdkdkd	

Third Group:	*Still Faster*
isisisisisisisisisisisisisisisisisisisisisisisisisisisis	3
isisisisisisisisisisisisisisisisisisisisisisisis	3
thisthisthisisisthisthisisisisisthisthisthisisisthisthisisisisis	
thisthisthisthis for for for for for for for for for for for for for for	3
Element Element Element Element Element Element Element	
FOR FOR FOR FOR ELEMENT FOR FOR	
FOR FOR ELEMENT FOR FOR ELEMENT FOR FOR ELEMENT FOR FOR	
thisthisthisisisthisthisisisisisthisthisthisisisthisthisisisisis	
thisthisthisthis for for for for for for for for for for for for for for	3
Element Element Element Element Element Element Element	
FOR FOR FOR FOR ELEMENT FOR FOR	
FOR FOR ELEMENT FOR FOR ELEMENT FOR FOR ELEMENT FOR FOR	
thisthisthisthis for for for for for for	
for for for for for for a;sldkfjghfjdksla;sldkfjghfjdksl	

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[31] Columbia Record, No. A-7578.

TABLE III

PERCENTAGES OF GIRLS OF VARIOUS AGES WHO REPORT THAT THEY WOULD "LIKE BEST" TO BE (*a*) STENOGRAPHERS OR TYPISTS, (*b*) MOVIE ACTRESSES

(From Lehman and Witty [32])

Age in Years	Typists	Movie Actresses
10½	14%	29%
12½	26%	17%
14½	31%	10%
16½	32%	5%

of interests in real-life vocations is neatly illustrated in the proportion of boys willing to be cowboys. Almost two thirds of Kansas boys asked at the age of 8 years are quite willing to be cow hands; at the age of 14 less than one fourth are willing. As young men of 18 years, only 4% confess any hankering for the open range; and, likewise, only 5% of the older girls still dream of stardom in the movies. Such interest shifts continue. Two years after McHale[33] questioned 133 college juniors, only one fourth of these college girls were pursuing their first choices of life careers, and less than one third their second choices.

Similar changes in interests are often compelled by sheer circumstances. If all young people could gratify unrestrained interests, certain occupations would literally be swamped. The interest counts by Proctor[34] and Douglass[35] are well known: three fifths of high-school students would swirl into the already crowded vocations; more than one half of the girls would become teachers, close to one third of the boys engineers. Yet less than half the high-school seniors seem to have any clear notion concerning the sort of paid work on which they want to embark next year or the further preparation needed. This uncertainty as to a vocation applies also to commercial students. Have you finished with such uncertainty? Are you riding the crest of a vocational incentive in your present typing class? Have you perhaps chosen a private secretary's role as your elevator to business success? At least you should feel the potential value of typewriting skill in many paid positions.

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[32] Lehman, H. C. and Witty, P. A., "The Constancy of Vocational Interests," *Personnel Journal* (1929), Vol. VIII, pp. 253–265.

[33] McHale, K., "An Experimental Study of the Vocational Interests of a Liberal Arts College Group," *Journal of Applied Psychology* (1924), Vol. VIII, pp. 245–255.

[34] Proctor, W. M., "Psychological Tests and Guidance of High School Pupils," Monographs, No. 1, *Journal of Educational Research* (1923).

[35] Douglass, A. A., "Vocational Interests of High School Seniors," *School and Society* (1922), Vol. XVI, pp. 79–84.

2. *An inventory of your vocational interests.* If you think through the many fascinating lines of livelihood and determine on a role that takes typing skill, what a powerful drive you bring to the typewriting class. A brief but systematic study of your personal interests will clarify the typewriting class from this angle. Surely you prefer to make this an attractive study while you are still a student rather than delay until later, when you might otherwise be both unemployed and disheartened.

An individual case history of yourself is the first step for uncovering a practical vocational interest. Of the many models already available for such study, the Minnesota Unemployment Research project[36] is one of the most recent. To the individual case histories, however, this Minnesota project adds surveys of available positions, with job analyses of all important skills and the training needed, surveys of changing employment demands, and surveys of industries or individual firms that are poor vocational risks. A vocational interest can shine under financial and other rewards, but it can also wane as crowding competition leaves the rewards and the desirable positions scant and less sure. There are three steps in an individual case history: first, a summary of your personal background, as already pictured in Chapter II; second, tests of your vocational interests in the light of your abilities; third, a physical and medical examination.

Your interest is only one indicator of your future fitness in a certain office. Besides interest, candidates for this or that vocational life-line should tab off "weakness" or "strength" in their special education, winning abilities, humdrum health, and many-sided personality assets. For illustration, if you have already checked the Bernreuter Personality Inventory,[37] observe that the lowest 10% of student scores may signalize unfitness for employment until better adjusted. Likewise, the successful office worker should probably show, besides good general ability, a stable personality, slightly extrovert, not too dominant or aggressive, with self-sufficiency within a moderate range. Even when personality assets, physical condition, and abilities appear adequate, there are intimate questions, too, about personal or family resources to carry the advanced preparation required.

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[36] Stevenson, R. A., "The Minnesota Unemployment Research Project," *Bulletin*, Vol. I, No. 1 (Employment Stabilization Research Institute, University of Minnesota, 1931).

Nonvocational interests may add a lively hue to this very personal picture. Among others, King[38] has developed a definite schedule, quickly checked, to record 47 varied interests of younger students while in high school. Of similar value are the revised lists of Brainard's[39] *Specific Interest Inventories*, such as Form B for boys.

You readily catch the purpose in this self-study through such intriguing lists of likes and dislikes as Garretson[40] has arranged for high-school freshmen. Therein are the possible interests in occupations, things to do and to own, magazines and the school paper, school subjects, qualities admired in people, prominent persons, and the doings of parents. This list will sort out three of every four boys interested in a commercial course. A third of commercial-course boys appear, in the light of these check lists, more interested in an academic course; a fourth, in technical courses. The mere fact that a youth has commercial interests, in the light of these check-list interests, does not guarantee his future success in commercial work. High interest scores, for instance, do not regularly accompany high scores on the Ruggles clerical test.

Finally, as you enter upon typewriting, just what incentives are at hand in your present vocational interests? At least one definite schedule should be at your elbow to help answer this query. Such interests are measured by Strong's[41] *Vocational Interests Inventory*, Manson's[42] *Occupational Interest Test* (for girls), or the Hepner[43] *Vocational Interest Quotient (V.I.Q.) Booklets.* If you are a young man, see if your adviser[44] will furnish you with a Strong interests blank and its scoring stencils. After you have checked over 400 of your interests in a lively twenty minutes, scoring stencils will show how closely your likes and dislikes parallel those of office clerks or purchasing agents or certified public accountants or salesmen. From the C. P. A. stencil, for example, you can say:

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[37] Recall the discussion on p. 27.

[38] King, L. H., *Mental and Interest Tests*, Contributions to Education, No. 444 (Teachers College, Columbia University, 1931).

[39] Brainard, P. P., *Specific Interest Inventories* (Psychological Corporation, Grand Central Terminal, New York, 1932).

[40] Garretson, O. K., *Relationships between Expressed Preferences and Curricular Abilities of 9th Grade Boys*, Contributions to Education, No. 396 (Teachers College, Columbia University, 1930). Check lists, pp. 10–17; scoring key, pp. 30–31.

(*A*) Yes, I already have the interests of a certified accountant.
(*B*) Maybe I have his interests.
(*C*) No, I do not have his interests.

Strong has standardized among successful men his scoring stencils for at least twenty vocations. Young women, too, may check their interests by these stencils, often with surprising discoveries. It is only because the interests of men and women closely approach within a common vocation that this is possible.

Any girl, similarly, might swiftly check her likes and dislikes upon the Manson list[45] of more than 150 occupations. This is the identical list of vocations which 13,752 employed women recently checked. More than five thousand were clerical workers. These women in office work liked about one fifth of the vocations and disliked about one third. You will find it illuminating to compare the way you check this list with the interests of women already in clerical work. Do your likes rather coincide? If so, you are a step closer to the interests of stenographers and clerks.

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[41] Strong, E. K., *Vocational Interests Inventory*, sample set, scoring stencils for 24 vocations (Stanford University Press, Stanford University, California).

[42] Manson, G. E., "Occupational Interests and Personality Requirements of Women in Business and the Professions," *Michigan Business Studies* (University of Michigan, 1931), Vol. III, No. 3, pp. 281–409.

[43] Hepner, H. W., *Vocational Interest Quotient Booklets* (Psychological Corporation, Grand Central Terminal, New York, 1931).

[44] Smith, R. B. and Rulon, P. J., "Report of a High School Personnel Department," *Journal of Educational Research* (1930), Vol. XXII, pp. 375–380.

[45] Manson, G. E., *Woman's Occupational Interest Blank* (Bureau of Business Research, University of Michigan, 1930).

TABLE IV

OCCUPATIONS FAVORED BY WOMEN CLERICAL WORKERS[46]

Accountant
Auditor
Bank clerk
Business for self (L)
Business manager
Cashier
City or county clerk
Clerical worker
Commercial teacher
Companion
Court reporter
Credit manager
Domestic-science teacher
Executive
Florist
Government clerk
Homemaker (L)
Hostess (hotel)
Housekeeper
Interior decorator
Lawyer
Librarian
Musician
Notary public
Office manager
Post-office clerk
Public stenographer
Secretary (L)
Singer
Social secretary
Social worker (L)
Stenographer
Tearoom proprietor
Treasurer
Typist
Wife
Y. W. C. A. secretary

(L) Most *other* women workers also favor.

Do you check a liking for a career as homemaker? Of all these thousands of employed women, 79% would like homemaking and only 5% dislike it. Even successful secretaries feel the attraction of this alternative path.

TABLE V

PER CENT OF LIKING AND DISLIKE FOR PRESENT OCCUPATION AND FOR HOMEMAKING AMONG STENOGRAPHERS, PRIVATE SECRETARIES, OFFICE CLERKS[47]

Employment	Like		Dislike	
	Present Occupation	Homemaking	Present Occupation	Homemaking
Stenographers	84%	74%	5%	5%
Private secretaries . . .	92%	78%	2%	8%
Office clerks	67%	77%	10%	5%

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[46] Manson, G. E., *Woman's Occupational Interest Blank* (Bureau of Business Research, University of Michigan, 1930).

[47] *Ibid.*

Besides weighing in the balance homemaking and a clerical pursuit, consider your preference among clerical roles. The usual stenographer would rather be a secretary, possibly an office manager, but not an office clerk and certainly not a file clerk. The usual office clerk in turn would be either clerk or secretary, but would think twice before considering a stenographer's job and would hesitate even longer over a file clerk's job.

TABLE VI

ORDER OF PREFERENCE FOR 6 OF 13 CLERICAL POSITIONS AS EXPRESSED BY STENOGRAPHERS AND OTHERS[48]

Position	Stenographers	Private Secretaries	Office Clerks	Bookkeepers	Office Managers
Secretary	1	1	2	2	2
Stenographer	2	3	8	8	6
Typist	3	4	4	9	7
Office Manager . . .	4	2	3	3	1
Clerical Worker . . .	7	5	1	4	4
File Clerk	13	13	11	11	13

After you check the Manson list of occupations, apply a scoring stencil to discover how closely your likes and dislikes coincide with those of stenographers. There are Manson scoring stencils for ten vocations. It appears that only 6% of stenographers check the interests which trained nurses feel; only 27% check the interests of sales proprietors; only 30% check those of retail saleswomen; 35% check those of grade-school teachers; and 42% check those of high-school teachers.[49] Obviously, these interests of stenographers are quite different from the likes and dislikes of, say, trained nurses, saleswomen, or schoolteachers. The mere working through of these facts, gathered from thousands of employed women, may help to clarify your own vocational interest.

In addition to these interests in occupations as such, a girl typist should uncover her likes and dislikes or indifference for more than

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[48] *Ibid.*

[49] *Ibid.*

150 detailed activities or elements entering into vocations. These more specific interests, such as preferences for certain surroundings and types of people, are checked in the Hepner booklet (for women). Your own scoring, by a clever device within the booklet, shortly brings out which among two dozen occupations lend you high vocational interest quotients.

To feel these interests may be a clearer sign of your future success in the commercial world than is your present typewriting ability. Indeed, the personal ratings by supervisors of your interest, personality, and degree of success plus promotions and earnings seem a better sign of ability to hold a job than the Thurstone typewriting-test scores. Bird[50] notes that such ratings reach 271 for successful typists, but fall to 145 for those leaving and to 131 for those discharged. Such personal ratings by supervisors or teachers, incidentally, gain markedly in definiteness by use of a Probst[51] service-rating plan. The public-service form of the Probst schedule, for instance, holds detailed trait phrases descriptive of your work and conduct. Illustrative of these carefully gathered trait phrases are "slow moving," "talks too much," "might be more orderly," "generally looks for easy work." Whenever you are checked against nearly 100 of these different trait phrases, an automatic scoring device assigns you one of eleven ratings from a possible plus A down to minus E. Such ratings reflect your sustained interest in your work. "Achievers" have been contrasted by Turney[52] against "nonachievers" in high school. The "achievers" reflect sustained interest, at least in the eyes of their teachers. Solid achievement does not necessarily follow the flashier traits. Such advantages may be wasted as an attractive "front," which conceals lack of sustained interest underneath the glitter. Kelley[53] believes interest more than half as important as ability. Hull[54] ascribes success 15% to chance, 50% to ability, and 35% to industry and willingness. Doubtless you have already decided that sustained interest counts heavily, even in school success.

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[50] Bird, Norma, "Relationship between Experience Factors, Test Scores, and Efficiency," *Archives of Psychology* (Columbia University, 1931), Vol. XIX, No. 126.

[51] Probst, J. B., "Service Ratings," *Technical Bulletin*, No. 4 (Bureau of Public Personnel Administration, University of Chicago, 1931).

[52] Turney, A. H., *Factors Other than Intelligence That Affect Success in High School* (University of Minnesota Press, 1930).

[53] Kelley, T. L., "Principles Underlying the Classification of Men," *Journal of Applied Psychology* (1919), Vol. III, pp. 50–67.

SUSTAINED INTEREST THROUGH THE TYPING ASSIGNMENT

1. *The assignment as an incentive.* You have found that many social and vocational incentives intensify the stimulation for your typing practice.[55] Interest indicates the intensity of your drive toward a definite typing goal.[56] You really want it! Perhaps this goal is 50 or 60 or 100 net words a minute in speed tests. Perhaps this goal is a workbook contract[57] to be typed at your own individual rate. Whatever raises the stimulation needed to sustain the necessary practice is an incentive. Thus, your introduction to lively machine dictation or to slowed motion pictures of expert typing could be an incentive.

In the modern typing class a variety of these incentives is planned. Skillfully these incentives are marshaled in each task assigned to you. Good assignments are thus grounded on your interests. In the lively presentation that launches an important assignment, your typing teacher may throw all the influence of his personality as a further stimulation. Perhaps this stimulation grows in liveliness by spirited discussion among the students as a group. In short, your assignment as planned brings incentives to a focus. What is this focus? It is called variously your task, problem, felt difficulty, intention, goal idea, assignment. Of course, your practice task is carefully charted before you start.[58] This definite intention becomes your guide through the typing study. If you fall into false moves, you merely press your resolve to do what you intend. Quite unexpectedly, if you are resourceful, better moves arise, perhaps as hunches. The unexpected strength of your intention, however, is not accidental. How could it be, with a planned variety of incentives?

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[54] Hull, C. L., *Aptitude Testing* (World Book Company, 1928), p. 193.

[55] See Filter, R. O. and Held, O. C., *The Growth of Ability* (Warwick and York, 1930), pp. 151–153.

[56] See McCall, W. A., "What's the Matter with Psychology and Measurement?" *Journal of Educational Research* (1927), Vol. XVI, pp. 179–183.

[57] See Clem, J. E., *The Technique of Teaching Typewriting* (Gregg Publishing Company, 1929), pp. 258–261.

[58] See Palmer, A. R., *Progressive Practices in Directing Learning* (The Macmillan Company, 1929).

2. *Co-operative typing projects.* Your social incentives are clearly illumined in assignments of typing projects, such as supplying clean copy for the school newspaper or magazine or annual.[59] Here you reveal the solidarity of school spirit in a co-operative school project. Here is improvement by typewriting in a social situation at its best. It is unfortunate that some teachers seldom seize full advantage of these co-operative school projects. Does it surprise you when only one fourth of 160 typewriting teachers tell Weersing[60] that they assign their students practical stenographic work for other teachers or the school office or for local business men. If a student is to become a vocational typist, the common omission of part-time typing experiences in local business offices is a neglect of his proper training. Twice as many teachers assign school office typing to furnish practical projects. No wonder student intention rides roughshod through difficulties whenever it can be one with the practical goal in this useful typing.

3. *Group-study plan for learning to typewrite.* The rise of social incentives is accorded full play if you are able to share in a group-study plan.[61] Perhaps your typing class is already an "office unit," with student managers and secretaries. The class resolves naturally into small teams — slow, average, or fast — each geared to its own gait. As soon as each little squad organizes into a compact social unit under its student leader, varied incentives arise. The assignments are informal affairs between group and typing instructor. In such mutual discussion typing practice is worked out and charted. While the instructor assigns practice, checks, and reassigns in the light of these checks, you find yourself in one of two, three, or even four very active squads cleverly handled separately at the same time. Your instructor is free to move about from group to group, assigning and checking. Your group may advance at a different rate

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[59] Compare the widespread group typing of class newspapers, plays, reports, and other projects in Wood and Freeman, *op. cit.*, pp. 15–17, 57, 91, 94, 129.

[60] Weersing, *op. cit.*

[61] Maguire, E. R., *The Group-Study Plan* (Charles Scribner's Sons, 1928).

under a varying incentive in the same period. Re-classifying can be frequent. Such co-operating groups seem particularly helpful in early or slow stages.

4. *The warming-up period.* A glimpse at how incentives sustain an assignment can be caught at the very start of practice. There is a brief gap before incentives really take hold. The gap may be noticeable. A "warming up" may be needed to offset the slow start upon a day's typewriting. This may consist of individual exercises practiced while the class is settling down. Suppose you consider, simply as further illustration, a sample task of fitting curiously shaped blocks into a form board. For this, Skaggs[62] sees initial slowness offset by "warming up" in about 40% of student attempts. The usual trouble is the time wasted while disengaging personal feelings about preceding matters. Recent attitudes from the last study or class still interfere. Thus, one youth always complains that he cannot "get into it." Another enters the classroom with a "Let's go!" attitude that leaves his muscles too tense. This "warming-up" period can be shortened, perhaps eliminated. It is shortened by whatever makes you keenly alert to do your best from the outset. If you step up to the practice with a lively competitive spirit, this may be your manner of growing absorbed immediately in the typing task at hand.

KNOWLEDGE OF RESULTS

When all is said and done about incentives, the last word on rapid improvement comes from competition against your own record. This competing against yourself as an incentive is known as "knowledge of results." No matter what your fingers are doing, the more you know about the records being made, the higher your efficiency mounts. This has been fully shown. Thus, the middle left finger has been harnessed for lifting a weight repeatedly.[63] Knowing the results of the lifting gave 18% greater efficiency. Chest weights have been used in the same way.[64] Apparently each student does more when he competes with his own record and can see the results of his work. The incentive from knowledge of test results has been brought out by Deputy[65] with college freshmen. All scores of daily ten-minute quizzes were always placed on the blackboard. Each student was urged to keep a personal record of his points. On the mid-semester examinations this class averaged 118, as compared with 105 by a class not so favored. This result depends, of course, on a favorable attitude in the class, and might not appear if a large share of the class were hostile to frequent tests.

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[62] Skaggs, E. B., "A Study of 'Warming-up' in the Case of a Task of More Complicated Perceptual Motor Co-ordination," *Journal of Applied Psychology* (1931), Vol. XV, pp. 499–511.

[63] Arps, G. F., "A Preliminary Report on 'Work with Knowledge Versus Work without Knowledge of Results,' " *Psychological Review* (1917), Vol. XXIV, pp. 449–455.

The powerful incentive inherent in knowledge of your typing results demands an elaborate setup in its behalf. It is desirable that a daily, weekly, or monthly sheet show your production of typed lines, that a rising curve of speed-test scores chart the exact level of your progress, that public posting of class and superior-student scores reward personal achievement.[66] Careful charts that regularly plot each student's progress in such graphic fashion are one of the brilliant achievements of most typewriting classes in comparison with most other courses. Does it reassure you to know that half the typing instructors in touch with Weersing[67] use these charts, while even more add recognition for special typing achievement? To know that you are a success as a typing student is the best of all incentives.

INTERPRETATIVE SUMMARY

The core of successful personality in the student typist is emotion. His desires contribute to its make-up. From this personality make-up come the sustained interests necessary to maintain productive typing practice. Any felt learning difficulty, by obstructing these interests, serves to heighten the attack upon the typing studies.

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[64] Crawley, S. L., "An Experimental Investigation of Recovery from Work," *Archives of Psychology*, No. 85 (Columbia University, 1926).

[65] Deputy, E. C., "Knowledge of Success as a Motivating Influence in College Work," *Journal of Educational Research* (1929), Vol. XX, pp. 327–334.

[66] See, for instance, Minich, Lola, "Motivation in Typewriting," *Balance Sheet* (1932), Vol. XIV, pp. 81–82.

[67] Weersing, *op. cit.*

The efficient typing class is organized deliberately to stimulate these interests. Various incentives supply this stimulation for efficient practice.

The young typist is stimulated by new social incentives if he enters into the joint projects, stunts, rivalries, and applause of a lively social group. The tremendous innovation of personal typewriting in school and workaday life and the fascinating appeal of the portable typewriter for the youngest children in school reveal typewriting today as an incentive in its own right. Systematic helps to uncover vocational interests are recounted. The discovery of interests in numerous occupations wherein typing is an asset contributes vocational incentives to sustain the typing advance. The very assignments to typing study are presented as stimulating challenges. "Knowledge of results" supplies the necessary checks on this study, and becomes an added incentive. The close recording of greater "line-production outputs," of fastest "net scores," and of rising "curves on progress charts" permits each student typist to compete with his own record. To feel these varied incentives, to taste a known success, speeds and sustains the typing practice.

PART TWO

TYPEWRITING IMPROVEMENT, TOLD IN FOUR APPROACHES FROM PSYCHOLOGY

CHAPTER IV

FOLLOWING A CHARTED PATH OF SKILL

* * *

READING SUGGESTIONS

To the Student Typist: In order to apply motion study to your own later typewriting, this brief chapter is a necessary introduction.

To the Psychology Student: This chapter presents a simple statement of the nature of thinking, and (pages 77 to 79) a scientific motion study, with the "situation" as the unit.

To the Typing Instructor: This chapter amplifies the view of typing study as thinking along a path charted by motion study. It introduces the Gilbreth technique.

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THE ESSENTIAL COMPROMISE BETWEEN TALKING AND DOING

The story of your personal typewriting triumphs can be short and straightforward. Upon a neat progress chart the curve of typing scores can rise from less than no net words per minute to perhaps 60 words per minute. A curve may display curious up-and-down zigzags. Perhaps a real quickening of progress flashes forth, and then a slackening. Yet the curve tells a simple story, if only by rising slowly month by month.

The detailed story behind this rising curve, however, must be told in English. All English follows a conversational line and is strung along like a series of beads.[1] One item is told, one variable is accounted for, one pointer is pointed, then another and another and another. In this fashion, thinking is carried by language. Yet, in sharp contrast with written or silently spoken English, your typewriting class launches its detailed variables practically at once. In order to become skillful, you must tie together all your typing performances. This is called *integration*, tying many parts into one whole. In everyday living you are not used to noting so many complicating details at once. In slowed motion pictures of typewriting the whole typist can be seen working at once. All such pictures are impossible in detailed English prose.

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[1] Miles, W. R. and Segel, David, "Clinical Observations of Eye Movements in the Rating of Reading Ability," *Journal of Educational Psychology* (1929), Vol. XX, pp. 520–525.

Written English, then, is a compromise which falls back upon the warning that its long lists of typewriting variables will emerge as one total pattern. Reading these pages will be somewhat like watching a dirigible balloon break more and more apart in a storm. Remember that the dirigible must be built together again before it can sail back into the skies. Can you translate into actual typing this discussion of its piecemeal aspects? Can you see through this artificial necessity of having the story of typing improvement grow more piecemeal and detailed? This discussion must be carried by your eye and throat muscles, by your reading and silent thinking. Typewriting, by contrast, must be carried by the muscular tensions of the entire body, known as postures and motions. As this typing performance becomes more and more complete, increasingly you will realize that verbal thinking is a supplementary help. You will appreciate that experimenting with your own body tensions or motions before the typewriter is far more important. With the aid of a continuous progress chart, you will be able to check up the results of this experimenting before the typewriter. With the aid of this chart you will also be able to overview the entire typewriting course. This training becomes a single stretch of time during which you will unify body posture and typing motions. This new integration popularly is termed *good form.*

THE THINKING MACHINE AT WORK UPON TYPEWRITING

1. *How a thinking machine works.* The commercial department is designed to help you develop into a thinking machine capable of handling commercial tasks. While you are learning to use the typewriter, the thinking machine is at work upon problems. Its energies should not be frittered away in a high-flown educational vocabulary. When instructors handle human brains as thinking machines, you and other typing students start to think and readjust yourselves.

The way to start a machine at rest is to upset its balance. When you are challenged in a typing assignment to do something new and different, temporary difficulties should upset your comfortable body balance. Tightening of your muscles results and automatically forces you to grope for any typing act that may lessen this tension. The usual method in academic classes is to grope with throat and eye muscles for the right answer in words, since the greater ease of word symbols over actual experimenting is obvious. Before a typewriter you also grope with finger and forearm muscles, supported by fixed posture. The power of this tension in the muscles reflects the intensity of your interest. Your guide in discarding unfit solutions is more tension from a felt difficulty. Sooner or later, however, a suitable action naturally releases the excess tension. This release is extremely pleasant and satisfying. Its feeling is so pleasant that the successful student is readily guided to persist in problem solving — with a typewriter.

2. *Learning to typewrite by thinking.* The necessary "steps" in thinking are too familiar to list, were it not for their neglect in practice. They are the skeleton of science work.[2]

(1) You are challenged or aroused to do something, but soon feel a difficulty blocking your new desire.
(2) You break this difficulty into more familiar items and thus define it.
(3) You find related items from experiment, classmates, instructor, demonstrations, library.
(4) From this mass of facts you hit upon suggestions or clues and size up each.
(5) You eliminate one suggestion after another until some better suggestion seems to fit all your facts.
(6) Your tested solution is now a part of yourself. You are able to demonstrate your result to the class group for its check. A final check rests with your instructor, perhaps by a definite typing test.

To dissect the customary abstract mystery out of thinking is to promote your typing improvement. As pointed out by Powers and Uhl, the acquisition of skill follows a similar pattern.[3] View learning as problem solving or adjustment along a definite path. Once you start to specialize in typewriting, let your instructor re-switch you into natural, definite, and progressive adjustments to felt difficulties. Learning to typewrite, like learning to swim or play hockey or win a decathlon, is a process of progressive adjustment and involves you in problem solving.[4]

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[2] See Powers, F. F. and Uhl, W. L., *Psychological Principles of Education* (D. Appleton-Century Company, Inc., 1933), pp. 81–82.

[3] *Ibid.*, pp. 89–91.

3. *Gaining a new, balanced adjustment.* Consider once more your nicely balanced body. Clearly you are built for balance. Not only are you built for balance, but also your nervous system is the most delicate balancing machinery in the world. Throughout waking hours your brain is sending little impulses, like electric currents, to all your muscles. In this way each of your hundreds of muscles is kept toned up or active. In this way you hold a firm body posture. Every muscle is telegraphing back in an automatic way to your brain that all is well and neatly toned up.

Then something of interest happens in the world about you. This world is your typing class, your school, your home, your neighborhood, downtown, or wherever else you are. If this something interests you, it has upset a bit that delicate balance of your body. Again your nervous system is about to bring you back to a more or less satisfying balance. You are sitting down before a reliable friend, the typewriter, and starting the motions of typewriting. Whenever an excellent letter of application is typed and mailed, for example, a disturbing gap is closed. Perhaps you heave a sigh, but it is a satisfied sigh, and there is pleased relief. The need to do something has disappeared, because you have done it. You have improved your skill.

Perhaps an illustration of problem solving by a psychologist will be reassuring. During his typewriting, Scott's[5] machine developed a mechanical defect which made it impossible to print the capitals. Isn't such irritating interference enough to bring a real body upset? Note the clues with which Scott groped for a way out of his keenly felt difficulty. First, however, he defined the problem by noting that the ribbon carrier would not lift to meet the type when the shift key was used. Starting with the obvious causal relation between pressing a key and the lifting of the ribbon carrier, Scott inferred that something had become unhooked or loosened, somewhere between key and ribbon carrier. He traced the complicated mechanical relationships of his typewriter by a transfer of ideas from his experience, such ideas as "I must proceed in a systematic way," "friction will produce wearing," "directions of force when inclined planes are brought together in various ways," "actions of springs," "levers," and "machines work as units." After two hours of this careful experimenting, testing out this clue and rejecting that, the source of the trouble emerged. With the completeness of his new idea of just what to do went a new insight into this sort of difficulty. The tension relaxed. The typewriter resumed its leisurely clicking.

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[4] See Wood, T. D. and Cassidy, R. F., *The New Physical Education* (The Macmillan Company, 1927), pp. 238–239 and 243–244.

[5] Scott, R. R., "Some Suggestions on Learning from the Point of View of Gestalt Psychology," *Journal of Educational Psychology* (1930), Vol. XXI, pp. 361–366.

CHARTING AN ADJUSTMENT PATH BY MOTION STUDY

Before losing yourself in the many details of felt typing difficulties, consider your typing class as a changing social situation. Of course, you are so much a part of this changing class that you are changing, too. Doubtless in the end you will emerge completely changed into a skillful typist. Fortunately, there are handles by which you can take hold of this entire typing-class field. For a start you might break the field artificially into three handles or *aspects*, following the famous motion-study experts, the Gilbreths.[6] To separate typewriting even into these three aspects is a violent act. Machinery is not run by tearing it apart and inspecting the parts outside the plant. Consider, however, variables of (1) your surroundings, (2) yourself, (3) your typing motions.

1. *Variables of your surroundings.* Here the Gilbreths would list the typewriter and its appliances; weights of units moved; comfortable, adjusted tables and chairs; comfortable clothing; special fatigue-saving devices; paper and other supplies; easily visible copy; lighting; proper ventilating; unavoidable noise;

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[6] Gilbreth, F. B., *Motion Study* (D. Van Nostrand Company, 1911).

rhythmic counting or music — even student traditions, rewards, and penalties. Nearly everything, advise the Gilbreths, can be important in surroundings.

2. *Variables of yourself, the student typist.* Here the Gilbreths point to the size and structure of your fingers, hands, arms, and body; your muscular strength; your general health and nutrition and mode of living; your experience, prior habits, skills, and training; the fatigue you bring to typing class and the later fatigue from typing; and your personality attitudes, the ways you feel about typewriting, about the relations between yourself and your classmates and your instructor. These variables outrun attempts at complete listing. The very surroundings are different because such an active party as yourself is present. Whatever you do influences your classmates and even more your teacher as he checks your work and assigns anew. Your attitude to these surroundings is so real that if you have the "blues," the surroundings seem blue. If you are gay, the setting seems gay. As far as you are concerned, the setting is actually changed by your attitude.

3. *Variables of your typing motions.* Here the practical Gilbreth listing suggests an altogether fascinating outlook opening upon your own study and invention of better motions — fewer motions, faster motions, easier motions — in short, the "one best way" for you to do typing. What are some of these handles to better motions? Gilbreth might compare you with an individual power plant so that you may study your own energy costs, the foot pounds of typing work in your motions. You will co-operate with the experts in the search for the least possible energy cost in typing assignments! There are the variables of speed, with its free momentum and rhythm and graceful acceleration. There are your starts and stops, perhaps better studied as inertia and momentum. There is the play for position as you combine each motion with the next in a lively series of movements known as typing sequences. At times, several motions may be transformed into one. Then there is the contrast between the beginner's unnecessary motions and the necessary motions of the expert typist. There are the direction of your motion, its path, its length, and the balanced keyboard plane in which you type.

There is much in the way of better motions for you to gain in the field of typewriting where the limits have not yet been reached. To separate yourself from the typing-class surroundings is quite artificial. To separate your typing motions from yourself is equally absurd. After all, it is you — your whole body dominated by your brain — who types. Whatever influences you modifies the finger-forearm motions. Fingers are not taken on and off like gloves. The exigencies of the English language force these artificial separations and must be offset by your own intelligent balancing of all these variables into one shifting whole.

As your enthusiasm for this pathway of motion study grows, the Gilbreths will meet you more than halfway. Try the clear-cut little book, *Motion Study*. It will make bricklaying motions almost as interesting to you as typing. Only as a nightly side line, if you are a homebody and still help at home, try out motion study on the dishwashing.[7] Or find an interest in the Gilbreth[8] devices which have made fast typists out of the blind and the crippled. If such success crowns the blind and the crippled, what are your limits with a typewriter?

INTERPRETATIVE SUMMARY

The story of typing improvement unfolds through a series of breaks with conventional typing instruction. The first clash arose as the growth of a well-balanced personality was raised to equal partnership with the growth of typing ability. A second serious break has now appeared in abrupt rejections of older attempts to "fix" typing-finger "habits" by repeated drills. In learning to typewrite, the fingers are incidental tools and any notion of fixed finger habits is detrimental to this purpose. Literally, the whole body, dominated by the human brain, types. Learning, stripped to essentials, is thinking. Learning to typewrite follows a widely varied, personal path of problem solving. The student typist's final discovery is to be the least possible action needed for his fast, accurate typing. This pathway has been brilliantly charted by the Gilbreth motion studies.

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[7] Gilbreth, L. M., *The Home-Maker and Her Job* (D. Appleton-Century Company, Inc., 1927), pp. 116–117.

[8] Gilbreth, F. B. and Gilbreth, L. M., *Motion Study for the Handicapped* (George Routledge and Sons, 1920).

Learning to typewrite is the actual thinking through of personal motion studies in order to discover and then to apply a supply of better motions to the successful operation of typewriters. This thinking starts with the desire to do and the felt difficulty blocking the new desire. This thinking is by definite steps, which include intensive searching for clues to better motions and whatever in typing equipment and surroundings or in the student typist himself may influence motions. These typing variables are to be detailed later. Amid this search for better body positions and motions, verbal thinking is often a help in defining successful clues. The day-by-day test of this thinking is the successfully typed assignment. By contrast with the routine practice of monotonous copybook drills, many of which might equally well have been published before 1890, the student typist will find thinking about motion study fascinating, modern, and productive as a pursuit.

CHAPTER V

PRACTICING CONTROL OF TYPEWRITING

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READING SUGGESTIONS

To the Student Typist: All that you need to discover in this chapter is just what is meant by tension and by *relaxation* in your typing. These are illustrated, for instance, in the reason for finger gymnastics, page 93. Most important is your learning how partly to relax muscles (partial relaxation), pages 95 to 99, and how this applies to your typing position, pages 94 and 95, and to your stroking of typewriter keys, pages 95 to 97.

To the Psychology Student: This chapter brings you to close grips with "behavior" psychology and today's emphasis on the muscular or reaction mechanism. Short of using special laboratory equipment, there is hardly a better way to gain an intimate contact with this mechanism than by study and practice of relaxation. A surprising neglect of this topic in many psychology texts accounts for frequent confusion between (*a*) a reaction merely relaxed away and (*b*) a reaction inhibited, or blocked. Nervous and muscular tension are briefly described, page 84. Of special interest are the accounts of excess tension while learning, pages 87 to 89, and of sustaining tension in all mental work as shown by the electrical tension in specific muscles, pages 89 to 92. The chapter guides you directly to carefully chosen pages in the authoritative source book on relaxation by Dr. Edmund Jacobson, pages 95 to 99.

To the Typing Instructor: This chapter explains in detail why trained relaxation is a key to successful typing by your students. The chapter leads directly into the authoritative source for relaxation technique, pages 93 to 99 (particularly differential relaxation, page 95). Note, also, that ballistic stroking is defined, pages 95 to 97.

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In terms of modern psychology, everyday typewriting changes lead to controls of certain muscles and relaxations of others. How these changes take place and how you can make them effectively will now be told.

In your typewriting class, before a modern typewriter and a typing instructor, you can be a very active person on demand — more forceful than you probably realize. Your classmates, too, can be individual whirlpools of activity. The typing assignments already appear crammed with hints for action. Consider this typewriting class, then, as a field of forces set for active changes. As you first find yourself in the midst of this active field, are you apprehensive when you realize that these changes are to occur in yourself? Can you see your initial dilemma? It is probably this: certain muscles are likely to become too active, as you work toward control; at the same time, other muscles will become so tense and stiff that efficient typewriting is out of the question.

Curiously enough, the changes in yourself are to happen in a direction hardly anticipated. You are to learn step by step the refinements of greater control and greater relaxation. As you learn to relax much of the tenseness felt in your muscles, you learn to typewrite. You will start at once to change many awkward movements when you discover that the pressure of numerous typing variables makes this direction your easiest way. Your final successful typing will be a series of delicate balances that bring less tension and greater control.

PLANNED CHANGES OF YOUR TYPING SITUATIONS

You have placed yourself in a classroom situation which demands fast and accurate typewriting as its final outcome. If this is a congenial class, there is already a considerable balance between yourself and other forces of this field. Your own changes to fit each new situation in this changing field should result in correct typing at the speed required. All the variables of the surroundings, of yourself, and of your motions are parts of this new situation — your machine, manual, instructor, comrades, and yourself. To face such a situation is a significant crisis in your school life. That it is a crisis is readily dramatized by the innocent-looking, three-stroke word *the*. Would you guess this to be a "typewriting demon" — that more errors, as, *teh*, *hte*, *eth*, *het*, *eht*, occur with this homely word than with any other word? Even second-year typing students stumble into errors on this everyday word relatively more often than first-year students. Typing is not simple unless you can simplify it yourself.

Educators have deliberately set up your typewriting class slightly off balance, as a well-planned field in which you are one of the active forces. Recognizing your active personality, they have set the unbalanced stage, with typewriters as props, so that what the instructor and the manuals start will be balanced by what you and other students do. When you have forcefully attacked these new difficulties, organized and solved them, you and your typewriting field will be balanced. The next day will present just enough new difficulties to upset the balance again. Perhaps you are already asking, "Is this to be an endless struggle between myself and ever-new difficulties?" Certainly not. Both you and your teacher have already agreed upon certain minimum limits. The moment you can type 40, 50, or 60 net words per minute, or whatever may be the desired standard, the field of the typewriting class is balanced and closed to your credit.

Next, suppose the field of forces of a typewriting class to be balanced and closed with credit, when you are clicking 60 net words a minute from your machine. You then enter the competition of a business office. You start office work with a key-stroke recorder on your machine. Under the numerous new requirements, your speed seems shockingly slowed. Even 60 net words a minute in the classroom may decline most unfortunately under office conditions. It is the privilege of you and your employer or supervisor to balance the commercial typewriting field at speeds which are the practical equivalent of faster classroom rates. Or the school balance is again upset if you enter state typing contests, for only superior speed will win and successfully balance a state field which holds the very cream of fast and determined student competitors. Indeed, if you are one of the few to climb toward the top of the expert column, a limit of about 150 words per minute for balancing the national contest field has not yet been reached. Superior typists rarely reach their upper limits of skills. Life is like that.

TYPING POSTURES AND TYPING MOVEMENTS AS NEUROMUSCULAR TENSION

1. *What is neuromuscular tension?* Do you grasp clearly the picture of the typewriting class as a field of forces to be balanced progressively by your own "neuromuscular" tensions and actions? Do you talk and think in terms of your progressive adjustments to the new typing class? Incidentally, have you stopped to dissect the hybrid phrase, neuromuscular tensions? *Neuro* refers to nerves, and *muscular* to your muscles. You may feel tenseness when nerves discharge impulses into muscles. You could witness a like demonstration with a simple make-and-break electric circuit in any elementary-physics laboratory. You can easily think of nervous tension, electrical tension, and muscular tension. For the reverse of these terms you should think both of inaction of nerves and relaxation of muscles. Merely for greater simplicity, you may take the nervous system for granted and speak only of muscular tension and relaxation.

2. *What is muscle tonus?* The higher centers of your nervous system generally keep muscles of your complicated body nicely toned, with just enough tension, or tightness, in the muscles for a comfortable balance. Perhaps it is reassuring to realize that the electrical tension present has passed by way of higher nervous centers, including your human brain, before arriving at the muscle. The slight shortening of the muscle fibers is called *tonus.* Your muscle tonus is thus the slight sustained contraction once thought characteristic of all healthy muscle.[1] That muscle tonus depends upon your posture and may be absent in any group of muscles was at length discovered.[2] It is maintained by signals (of which you are unaware) from the slightly contracting muscle to these higher nervous centers.

3. *Persistence of your typewriting postures.* Accordingly, as you sit before the typewriter, it is well to remember that every posture tends to persist. You may feel very positively that you are passing

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[1] Jacobson, Edmund, *Progressive Relaxation* (University of Chicago Press, 1929), pp. 266–269.

[2] *Ibid.*

from one position to a better, but the change does not happen as abruptly as you may believe.

The *persistence of posture* might be illustrated by this simple experiment: First place your arms correctly in a line parallel with the slanting keyboard, but with the fingers slightly raised above the home keys. Raise your arms to an angle of 45 degrees with the correct position (raising the hands about a foot will do this). Hold this new posture, perhaps counting twenty. Now close your eyes and return your arms to the correct position. As before, your fingers should not quite touch the home keys, but you feel certain that your arms are now back in position. What do you discover? Very likely the arms are dropped but are not entirely back to correct position even yet. Delicate measurements[3] would show each arm still rising and falling in slight rhythmic waves, which bring the arm nearer to the original position parallel with the keyboard's incline.

This is not an error of your judgment, but merely the persistence of the incorrect posture. This kind of persistence seems different from the persistence of your little finger's pressure against the shift key as you capitalize some letter. If this shift key, which your little finger presses down so firmly, were to break and drop, your finger obviously would tend to move in the downward direction. Such persistence would simply be continuing your action. Selling[4] suggests that you experiment with the arm lowered. You might stand and stretch your arms horizontally in front of you. Next, lower them 45 degrees. Then close your eyes and raise your arms to the former level. Do your arms go back to the horizontal or to a point still somewhat nearer the lower position? If you happen to be right-handed, this difference is more noticeable in your left arm. Your more skillful right arm follows posture changes more strongly, just as it is more strongly linked with the turning of your head.

Selling finds further that postural persistence appears in a mere movement of your arm upward followed by your immediate attempt at its return. If you should hold the new posture about twenty seconds, its persistence would be fully established.

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[3] Selling, L. S., "An Experimental Investigation of the Phenomenon of Postural Persistence," *Archives of Psychology*, No. 18 (Columbia University, 1930).

[4] *Ibid.*

Does this experiment suggest to you the delicate body balance implied in the mere holding of your arms parallel with the keyboard slant? You may lose the correct position, feel yourself back in it, and still be somewhat nearer the incorrect position which you momentarily chanced to assume. In fact, all the freedom and looseness of correct typing motions, with loose pivots in elbows, wrists, and finger joints, are strictly dependent on fixed postures in supporting parts of the body, such as shoulders and hips. Firmness below the waist is particularly in point. This implies, as Hartson [5] emphasizes, balanced tensions in opposing groups of muscles. The opposed muscles must pull one against the other, so that the body part is held fixed. In like manner, while reading copy, the free and loose motions of eye muscles are dependent on fixed tensions in neck muscles which steady the head. Persistent posture supplies the fixed support without which fast typewriting would be impossible.

4. *Irregular tension in inferior typing.* At the start, many new difficulties of the typewriter, whether of position or of stroking, disturb the balance in your nicely toned muscles. Any new situation which you have not learned to meet will do this. You are part of this new situation. Yet you are not adjusted to it, for your comfortable body balance is upset. Of course, the muscles of your hands and very likely of your whole body are very tense. This tension in your muscles may differ from tensions in the muscles of other typing students. There appear striking differences, for example, in the tension of the hand while tapping,[6] even as there are wide differences in muscular strength. Watching young children press a key whenever a red light flashed, Duffy [7] has noticed differences in their unused left hands. Some showed a regular line of high tension; others, a line of low tension. Still others are not continually keyed

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[5] Hartson, L. D., "Analysis of Skilled Movements," *Personnel Journal* (1932), Vol. XI, pp. 28–43.

[6] Duffy, Elizabeth, "The Measurement of Muscular Tension as a Technique for the Study of Emotional Tendencies," *American Journal of Psychology* (1932), Vol. XLIV, pp. 146–162.

[7] Duffy, Elizabeth, "Tensions and Emotional Factors in Reaction," *Genetic Psychology Monographs* (1930), No. 1, Vol. VII, pp. 1–79.

up, but show a moderate tension line which rises at times. These irregular rises probably indicate poor muscular co-ordination. Whenever the tension line is irregular, it seems as if the person does not have himself well in hand. Wide ups and downs, even in the tension of an unused left hand, seem to be a sign of poor co-ordination in the muscles. Under irregular tension, errors appear to be due to false motions; but under high, smooth tension, errors are apt to be mere omissions.[8] These are basic distinctions between a *steady state* of muscular tension and *irregular* tensions.

THE TYPING BEGINNER'S EXCESSIVE TENSION AND SELF-INTERFERENCE

The beginning typist wastes a great deal of energy, and excess muscular tensions actually endanger the success of early typing. This is illustrated when you bend your first finger, for instance, or even consider stroking a key. What is happening in other muscles? By photographing slight lever movements from thigh and arm muscles, magnified 500 times, Freeman [9] is able to measure the thickening of these muscles as each contracts. If the first finger of the right hand is worked at its hardest, muscles in the left hand and thighs also thicken. Only when your finger moves lightly does the tension fail to spread. The stronger your finger movements, however, the more the tension spreads to more and more remote muscles. This is illustrated when one is playing a piano with one hand by a noticeable clenching of the other hand and tensing of other body muscles. Also, in such a process as mental arithmetic, this spread of tension is almost constantly changing. If you set yourself to listen for the copy signals in dictation, muscular tension spreads in many ways. All this is your automatic bodily preparation for difficult acts.

With these measurements, Freeman [10] shows that it is chiefly the unpracticed who spend more energy for less returns. When, as a beginner, you attempt a new skill, such as a shift-key stroke, tension becomes widespread in many muscles. Later, as you become more skillful, only the muscles actually needed are tightened. By more delicate measures of tendons rather than of muscle thickening, Freeman discovers, for instance, a lessening in thigh-muscle tension as seven students learn a series of syllables. Within a few days, this tension with one student dropped in the ratio of 27 to 4; with another, of 16 to 2. Fortunately, your continued typing practice should likewise decrease your tension. Otherwise, too high tension would continue to block the fine interplay between muscles in fast typewriting. It is difficult to co-ordinate muscles under high tension. Even in finger tapping, Duffy [11] notices a fairly close relation between high tension and poor performance.

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[8] Duffy, Elizabeth, "The Relation between Muscular Tension and Quality of Performance," *American Journal of Psychology* (1932), Vol. XLIV, pp. 535–546.

[9] Freeman, G. L., "The Spread of Neuro-muscular Activity during Mental Work," *Journal of General Psychology* (1931), Vol. V, pp. 479–493.

[10] *Ibid.*

Such studies lead Freeman [12] to warn you that performance on a high level, as in typewriting, demands a certain amount of sustaining muscular tension, but that an excess will probably break up the performance.

If you care to turn to golf and the out-of-doors for a clear-cut sports picture, Grantland Rice [13] tells you that nearly every fault in golf comes from tension — "foozling," "dubbing," "flubbing," whatnot. In a duffer's tense grip on a club, his wrists immediately become wooden and stiff. Not only hands and wrists, but other muscles also, and even thinking, are locked together at the start by a dozen varieties of interfering tensions. If you hand this novice a golf club, he immediately clutches it in a viselike grip and becomes rigid from head to foot. Are you willing to make a like claim for typewriting?

Grantland Rice [14] also tells the story of a clever golf professional who watched or rather listened a moment, then said, "I want to see you hit the ball without grunting."

"Grunting?" his student asked. "Am I grunting? I never knew it." Yet he could be heard yards away. When this gratuitous noise disappeared, the swing also lost its body lurch and its violent heave.

[11] *Ibid.*

[12] Freeman, G. L., "The Facilitative and Inhibitory Effects of Muscular Tension in Mental Work," *Psychological Bulletin* (1931), Vol. XXVIII, pp. 687–688.

[13] Rice, Grantland, "Golf Course: The Duffer's Dilemma," *Collier's* (April 11, 1931), Vol. LXXXVII, p. 24.

[14] Rice, Grantland, "Swinging the Blues Away," *Collier's* (August 1, 1931), Vol. LXXXVII, p. 12.

Another pointed story by Grantland Rice is of an old Yale football captain, Sam Morse. So bad was this athlete's midseason slump that he couldn't even tackle. A coach watched for perhaps twenty minutes and snapped, "I have it. You're making a terrible face before each play starts. That shows how tense you are. Take it easy for a while." The football star was out of his slump at the next practice.

If this were a class in elementary singing instead of typing, you would hear many "throaty" tones, due to overtense throat muscles.[15] Perhaps in a public-speaking class you have experienced excessive tension. Doubtless you know students who become so tense when they are to speak in public that they do nothing but tremble tautly. Perhaps you have also seen some overtense billiard player spoil a delicate shot. Perhaps you will observe some students before a typewriting speed contest so excessively tense that good timing and speed are impossible. These tensions show poor control of deep-lying muscles within the body. Such extremes are mentioned to illustrate what excess muscular tensions are and the interference that ensues.

SUSTAINING TENSION IN TYPEWRITING

The new situation of struggling with a typewriter which you desire to operate is bound to heighten the tension of your muscles somewhat, so that you are ready to act. What is called your "interest" is simply the degree of this bodily tension. Heightened tension makes it possible also to "hold" your teacher's preliminary instructions while you delay your doing of them. Unless there is some tension, learning to typewrite is impossible. Typing depends upon the readiness of the arm-finger muscles and the supporting body parts. Certain tensions favor fast finger stroking, because muscles contract more sharply when already slightly contracting. The fact that distractions, within limits, may help your typewriting speed is due to these useful tensions in your muscles. Thus, Bills[16] has demonstrated that recall of words may be 20% better or your adding of numbers faster while you are tense. Not only is your level of efficiency higher under sustained tension, but also you are less troubled by fatigue. Naturally, you have often watched the track athlete warming up before his dash or the baseball pitcher before he addresses the batter. An advantage of finger gymnastics lies in this warming up or toning of your fingers before they start to race along the keyboard.

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[15] Jacobson, Edmund, *op. cit.*, pp. 82–83.

[16] Bills, A. G., "The Influence of Muscular Tension on the Efficiency of Mental Work," *American Journal of Psychology* (1927), Vol. XXXVIII, pp. 227–251.

Under certain conditions, co-ordination of your typing movements will be superior under higher tension. There must be sustaining tension, for example, whenever high bursts of speed are desired. Even a champion's concentrated expression under high speeds marks this necessary tension.

Are you positive as to just what is a feeling of tenseness? Experiment and observe until you are. Catch yourself at the very moment you are wrestling with a mathematical problem and feel the tenseness of your wrinkled brow, your strained eye muscles, perhaps even your clenched hands. Thinking is hard work.

Arrange for someone to interrupt you when you are busy at a hard, interesting task. Here is the interruption at your busiest moment! Do you catch it? Isn't the interruption an irritation and the interrupter a nuisance? Doesn't the tenseness in your muscles make you want to keep right on — trying?

Doubtless you are prepared to come face to face with a basic fact: the energy expended in neuromuscular tensions, as in finger-stroking words and phrases on a typewriter, is identical with the energy of your corresponding mental control over copyreading and its typing.[17] Typewriting flows from electrical tension in brain and muscles. You and your motions are as one.

You will admire the clear picture of sustaining tensions in brilliant experiments by Jacobson.[18] You already know that with tension in a muscle there is electrical potential. The tense part of a muscle is negative in electrical potential as compared with the relaxed part, which is positive. In these experiments, minute muscular movements are caught by delicate electrical measurements. By inserting pointed electrodes of fine platinum-iridium wire in a muscle, low voltages can be measured by the Sanborn string galvanometer. If this insertion is in the biceps muscle of the right arm and the arm is relaxed, the string in the electrical galvanometer is practically quiet. When the student starts to imagine bending his right arm or lifting a ten-pound weight, microscopic movements occur in this muscle, and corresponding vibrations are recorded by the electrical galvanometer.

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[17] Jacobson, Edmund, *op. cit.*, p. 295.

[18] Jacobson, Edmund, "Electrical Measurements of Neuro-muscular States during Mental Activities," *American Journal of Physiology* (1930), Vol. XCI, pp. 567–608, Vol. XCIV, pp. 22–34, Vol. XCV, pp. 694–712; (1931), Vol. XCVI, pp. 115–125, Vol. XCVII, pp. 200–209.

Such electrical action in the right arm was noted 159 times out of 163, as students relaxed and then simply imagined such right-arm motions as:

"Imagine lifting a cigarette to your mouth."

"Imagine grinding coffee."

"Imagine hugging."

"Imagine shifting the gears of your car to first speed."

When a student imagined acts done rhythmically, such as turning an ice-cream freezer, the galvanometer's string would vibrate and rest in like rhythmical succession. Suppose an expert typist should imagine himself typing contest copy, would you expect similar minute movements in a still more striking rhythmical succession?

A student whose left arm had been amputated above the elbow joint, said, "My imagination of bending the left hand is but a shadow — a duplicate of what the right hand is imagined to perform." Electrodes were placed in his partly amputated biceps muscle, and other electrodes at muscles which bend his right hand. As he imagined lifting a ten-pound weight on the finger tips of his amputated left hand, electrical action showed in the remnants of his arm muscles above the elbow and also in his right hand. Isn't this a clear picture of substitute muscular tensions? If absent from one muscle, minute tension will be found in another.

Suppose a student should next imagine that he sees himself bend his right arm. Now, the electrical action is absent from the right arm. Instead, it is registered from electrodes at the eye muscles. The galvanometer vibrates in quite different ways when he imagines looking to the right, to the left, or up and down. As he imagines his morning newspaper, the electrical records strikingly resemble looking to the right. The usual time for these minute eye movements is less than a second.

A sufficiently delicate apparatus, with a special circuit to record string tension per millivolt from speech muscles, was finally achieved by Jacobson and located away from electrical interference. Of course, it was first essential to train students to extreme muscular relaxation in order to isolate any slight contractions of speech muscles while thinking. Otherwise numerous tensions common in untrained persons would interfere. With tongue and lips relaxed, electrodes were placed in the tip of the tongue and in the cheek, or most often in the mid-line of the under lip. At the start of thinking with words or numbers, a minute electrical tension appeared in at least some of the muscles which participated when words or numbers were actually whispered or uttered aloud. Thinking "one, two, three," gave the same tension pattern as actual whispering of this count. Thinking of a poem resembled actual faint speech, but it produced considerably less voltage. By contrast, whenever the student imagined the Eiffel Tower, the minute tension shifted to the eye muscles. When he imagined lifting a ten-pound weight, minute tension shifted to the arm muscles. Tongue and lips were no longer active. In short, slight sustaining tensions appeared in the very muscles which would be engaged.[19] Do these illustrations of extremely slight electrical tension also suggest that as your typing practice goes on, the amount of supporting tension properly decreases? [20]

METHOD OF DIMINISHING TYPEWRITING TENSION

Do you appreciate the sharp contrast between steady, sustaining tension and irregular, excessive tension in your own muscles? The one favors your typing; the other interferes. Your learning to typewrite moves forward over a definite path of thinking about relaxation. You follow this path until you discover a fine, steady balance between tensions and relaxations.

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[19] Jacobson, Edmund, "Electrical Measurements of Neuro-muscular States during Mental Activities," *op. cit.*

[20] Freeman, G. L., "Mental Activity and the Muscular Process," *Psychological Review* (1931), Vol. XXXVIII, pp. 428-447.

1. *Relaxation by stretching typing muscles.* By way of further illustration, take corrective physical-education classes at the University of Washington. In these classes college girls liberate themselves from tension, stiffness of one kind or another, as each learns the fine art of relaxation and muscular control. Perhaps it has not yet occurred to you that modern physical exercises are less for the development of muscles than to stretch tense muscles until there is a finer adjustment of balance.[21] Unbalance from muscular strains is thus relaxed. Take walking as a homely example. If you were a member of Miss Jane McGownd's college class, you might be told:

> "Your walk reflects your thoughts. Think up and free, walk up and free. Feel light with your whole body. Do not walk as though you weighed a ton. Get a nice, easy swing and do not be afraid to look the world in the eye. Put your heels down first, lightly, quickly, heel, arch, toe, and push yourself forward with your toe. Think of flowing right along straight forward in a rhythmic manner, natural, normal. Do not lurch."

Can you frame like instructions for operating a typewriter? Do you practice finger gymnastics chiefly to develop finger muscles or to stretch them? Your typewriting time is valuable and not to be wasted in the practice of movements not used in typing. Typewriting motions should be learned exactly as they are to be used. Are your finger gymnastics actual typewriting movements or mere muscular activity which is wasting time? You have doubtless noted the advantage of warming up your fingers before a speed test. Do your finger gymnastics by any chance provide for stretching stiff muscles, as relaxation exercises? Skeptical as you properly are toward artificial finger exercises, do not overlook Crew's[22] report that a class which drilled finger gymnastics five minutes daily proved superior to a class which did not. Smith[23] would have you "free" your typing fingers by two to four minutes of daily gymnastics.

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[21] See Williams, M. S., *Growing Straight* (A. S. Barnes and Company, 1930), Chapter VIII, "How Indians Use Their Muscles," pp. 65–80.

[22] Crew, H. R., "An Experiment with Finger Gymnastics in Teaching Typewriting," Monographs in Education, First Series, No. 9, *Research Studies in Commercial Education*, Vol. III (University of Iowa, 1928), pp. 126–144.

[23] Smith, H. H. and Wiese, E. G., *Seven Speed Secrets of Expert Typing* (Gregg Publishing Company, 1921).

2. *Cultivating an effortless manner from a sitting position.* Grantland Rice [24] tells you that when a great golfer like Bobby Jones drives for distance, he keeps at least twenty yards within his limit, to eliminate all thought of extra effort or overhitting. Moreover, the speed of the club head as it strikes the ball depends largely on flexible hands and wrists. Not only must your left side relax on the backswing, but also your right side must relax on the downswing. So much for golf. In typing, relax your own hand and wrist; then fling this limp hand up and down at a terrific rate by a very fast motion from the arm. Can you feel the relaxation in your hand even while carried at this high speed? Can you imagine just enough tension in your relaxed fingers to start keys? Can you imagine how speed and partial relaxation go together? Get comfortable and natural — Grantland Rice urges — err on the side of looseness and lightness:

"If you can't play like a golfer, at least try to look like one."

If you can't typewrite like an expert, at least try to look like one — with a free and easy manner.

Grantland Rice believes movement is the great foe of excess tension. He could point to the value of the "warming-up" practice for relieving excess tension before you get into the swing of the game. He points to the smoothness of motion of a great pitcher like Walter Johnson — an almost effortless manner, free from any jerk. Yet your typewriting movements must be from a fixed sitting position — neither a pitch nor a lunge nor a wallop, but only serial finger action with smoothness, freedom, flexibility, and lightness. Can you triumph over the inactive sitting position?

The late Frank B. Gilbreth, celebrated industrial engineer, enjoyed telling how the most efficient window washer looked to be by far the "laziest" man — a Negro who with three easy swipes completely cleaned a window.

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[24] Rice, Grantland, "These Long Drives," *Collier's* (November 7, 1931), Vol. LXXXVIII, p. 19; (April 4, 1931), Vol. LXXXVIII, p. 26; (April 11, 1931), Vol. LXXXVIII, p. 24.

Can you learn to do essentials, yet omit nonessentials — to make necessary movements, yet omit others?[25] The golf or tennis player must learn to mingle a certain relaxation with the strokes in order to be successful. The esthetic dancer uses only muscles needed for the act, and no excess tension appears. The trained voice does not tire after long speaking. How about your typewriting?

3. *Partial relaxation of primary typing tension.* How can you be more relaxed while typewriting? This is a skill to be practiced, step by step, and applied at once. Like any other typing skill, partial relaxation arrives by trials and successes. Reading references to further your systematic attack upon this problem are readily assigned in Jacobson's *Progressive Relaxation.*[26] Although the book is technical, it should be in a typist's reference library because of several illustrated chapters which clarify a student typist's approach to relaxation.

Partial relaxation, which sets in as you become more skillful, is an absence of undue tension in typing muscles, while other muscles, not needed, remain limp. *Differential* is a better word than *partial* because the amount of relaxation differs, as needed, in different muscles. This is the way you control the various muscles used in typing.[27] Finely shaded tensions are needed in your posture before the machine; in your eyes, which follow the copy sentences; for some typists, in tongue and lips, which move in inner speech during typing; and in your fingers. Wherever some muscular tension is needed for typewriting, such tensions are called primary.[28]

Probably your primary movements are too intense. You are overexerting, you peer too intently at the copy, you stroke the keys too heavily. Probably the excessive tension in supporting shoulders and hips cannot be ascribed to unsuited heights of table and seat or other alibi. Jacobson adds, however, that "relaxation should be carried only to the point where maximum efficiency continues; beyond this it would interfere with the purpose in hand."

4. *Ballistic motions in typing.* As you try for a more relaxed stroking, it will help to observe that finger muscles, supported by forearm

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[25] Jacobson, Edmund, *Progressive Relaxation*, pp. 82–83.

[26] *Ibid.*, Chapters IV, V, VI, pp. 28–100.

[27] *Ibid.*

[28] *Ibid.*

muscles, operate in opposed sets. One group of muscles bends each finger, while an opposing group extends it. Naturally enough, any beginner tenses both groups, so that one pulls against the other. By contracting more muscle fibers and thus increasing the force of one of the opposed groups, the beginner is able to move his finger against the opposition. His muscles, though moving, are stiff and wooden. The result, to put it paradoxically, is his slow extension of a movement of holding still. The key is slowly stroked much as a driver's foot slowly applies automobile brakes for a gradual stop. If any beginner typist tries to speed with these tense muscles, the natural result is a breakdown. Omissions, for example, will follow as his tense strokes fall short and fuse.

In correct typing, as you soon learn to your advantage, the opposing muscles in the hand are balanced by partial relaxation. The working muscles are left unopposed. Some contract only at the start. These muscles are actually thrown, and momentum does the rest. This free momentum is possible only because the opposing muscles are relaxed. The finger then flies with all muscles relaxed. This freely moving momentum stroke is called *ballistic.* Since it takes more time to stop than to start such a downstroke, your learning will stress the getaway from the key. The downstroke is stopped by the tension of the opposing muscle group and contact with the key. The backstroke, as well, is a ballistic movement. Once started, the backstroke likewise flies back relaxed. Although such stroking is surprisingly light and free, this ballistic movement is powerful, utilizing the finger weight and its momentum. It is also most rapid and least fatiguing.

From parallel studies of telegraphers, you find that operators handling the key with the lightest touch do not increase pressure when speeding. Perhaps it no longer seems odd to you that operators with a heavier touch increase pressure when speeding. Another illuminating fact is that a group of operators complaining of finger cramps actually put 44% excessive pressure on the key. The ballistic movement is not only more rapid and less fatiguing, but it is also more uniform, precise, accurate. Insight into the balancing of primary finger-stroking tensions is derived in full from Stetson and

Hartson.[29] Just enough tension should remain to pivot each finger freely at the joints, as a light hammer head upon the typewriter key.

5. *Complete relaxation of secondary tension.* Probably you are making numerous wasteful movements which simply detract from your typewriting. These are due to secondary *tensions.*[30] If you do not have such tensions, you are among the select few who are already attaining remarkable skill in typing. Typical secondary tensions appear in any undercurrent of worries, thoughts, irrelevant recollections, or intentions to do this or that while typing. Slight, wasteful movements of your eyes, for example, can take on new importance if you realize from Jacobson that such eye movements, through important connections between your eye and your other muscles, may start disorderly tensions elsewhere in your body. You will want to relax all these useless nontyping tensions towards the vanishing point.

Just as you can speak in a general way of a curve of fatigue or mounting errors if you typewrite continuously and long, so you can speak of a rising curve of relaxation. To illustrate useless tension, suppose you take muscles that move the knee. With thirteen students seated writing, for example, with no direct activity of leg muscles, Jacobson [31] found the height of the knee jerk declined from 4½ centimeters to less than 1½ centimeters. (You are familiar with this natural jerk following a sharp blow just below the knee.) Is this not a clear picture of rising relaxation in leg muscles during 25 minutes of writing? When one girl changed to a higher speed of writing, the knee jerk increased; then it again declined. Whatever hinders relaxation always prevents the decline of all such useless movement.

6. *Jacobson's method of diminishing tension.*[32] Definitely, what is the Jacobson method of diminishing tension? In order to start your own study of partial relaxing, seat yourself slowly and limply in a chair. Then relax all your muscles as well as you can. You

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[29] Hartson, L. D., "Analysis of Skilled Movements," *Personnel Journal* (1932), Vol. XI, pp. 28–43.

[30] Jacobson, *Progressive Relaxation*, pp. 97–100.

[31] *Ibid.*, pp. 139–141.

[32] *Ibid.*, pp. 84–96.

realize, of course, that the average person often does not know when he is tense. Review the tenseness and relaxation of some muscle group, say your arm. Bend your forearm, moving the hand half an inch or less, so that you feel and locate its tenseness. Try lighter and even lighter bending (Figure 24, page 86 of Jacobson's *Progressive Relaxation*). Does your arm at last droop limply? Notice signs of your inadequate relaxation. Perhaps your head is only partly bent forward, with tension in your neck; perhaps your eyelids wink as in thinking; or your limbs appear somewhat stiff (Figure 26, page 90). Slightly straighten your back and note the increased tension, then let these muscles go as far as you can without falling uncomfortably forward or backward (Figure 25, page 87). For any muscle which you believe relaxed but find still moderately rigid, Jacobson urges, "To let go such a tension step by step, each time feeling that one can go no farther yet soon succeeding in doing so, is an accomplishment which, when first performed, marks a step forward in learning to relax." [33] After you are sitting relaxed, with no trace of restless movement, read a typing assignment while relaxing the lower limbs, the back (as far as sitting posture permits) and the chest (as far as breathing and inner speech while reading permit). With your forehead and eyes extremely relaxed, words cannot be read (Figures 27, 28, 29).[34] Then introduce just enough tension in forehead and eyes to follow words, but fail to get their meaning. Finally, contract your eye muscles just enough to get the meaning of the copy clearly and no more (Figure 30).[35]

The important result of this experimenting is that you have demonstrated to yourself what *differential*, or partial, relaxation is. The next step is to discover for yourself the greater ease of like partial relaxation in your typewriting — relaxing muscles not needed and lightening needed motions. The effect of such practice during reading or typewriting is to improve relaxation of your body. Your typewriting movements will lose their jerky aspects. Even your appearance at the machine will be more restful.

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[33] Jacobson's *Progressive Relaxation*, p. 89.

[34] *Ibid.*, pp. 91, 92, 93.

[35] *Ibid.*, pp. 94, 95.

RESIDUAL TYPING TENSION FOUND BY PROGRESSIVE RELAXATION

If you find it pleasant to experiment with relaxations, you will want to make this practice general and progressive. As you lie quietly in your room at home, many slight tensions still exist, perhaps in slightly irregular breathing or restless shifting of your head, perhaps in twirling a finger, tenseness about your eyes, wrinkling of your forehead, or frowning. Usually you are unaware of these slight but useless movements, which are called *residual tensions*.[36] Before you can relax in a progressive way, does it seem strange that you have to search for the whereabouts of certain of your own tensions? A feeling of tenseness is vague and indistinct and often slight. Certain tensions are not easy to locate. Some students confuse tenseness with the strain felt at joints and tendons. Do you? Extend your right arm straight out and swing it in a half-circle far to the left across your chest. Where do you feel muscular tenseness? By contrast, where do you feel strain? The latter should be felt in the shoulder, the former in the chest muscles.[37]

If you will try out one muscle group at a time, you should be able to experience its tenseness alone, while all other muscles remain so far as possible limp and inactive.[38] Thus, if you bend your forearm, rest the upper arm upon the couch and let the hand hang limp. You do this not to watch the movement but merely to feel its tenseness. Try out in this way some fifty muscle sets from fingers down to toes and up to eye muscles. To recognize and locate these various tensions is not an aid to relaxation. You merely learn what *not to do* when you relax.

After you experience the *tenseness* of a muscle group, then let it go, further and further every minute, as Jacobson[39] urges — past the point where it feels perfectly limp and relaxed. This relaxing of a muscle takes no effort whatever, is never hard, and is always a pleasant feeling. Lying at home, you can discover and practice relaxing this series of fifty muscle sets, one after another, from fingers to toes, finally to neck and eyes and throat, until at the close of this progression your entire body lies relaxed.[40]

[36] *Ibid.*, p. 29.

[37] *Ibid.*, p. 54.

[38] *Ibid.*, pp. 43–50.

[39] *Ibid.*, pp. 49–50.

[40] *Ibid.*, pp. 43–73.

SUSTAINED, RELAXED FOLLOWING OF COPY WITH A TYPEWRITER

The primitive notion that you or any other student must be urged into continuous, strenuous attacks upon the typewriter thus seems odd, even though it prevails in many a typewriting class today. The more desperate your striving became, the less would you advance. Such vigorous waste of energy would be out of place even in a prize ring. Even a pugilist values balance more than this overvigorous dodging and swinging. The slightest motion of the head, just enough to be missed, lets the blow go past the ear. Yet the sore arms, shoulders, and backs in some new typing classes seem to call less for a teacher than for an athletic trainer with attendant shower baths, rubdowns, and liniment massage. Perhaps this is not surprising when many experts ignore relaxation. In a detailed combing of sixty-one typing textbooks, Debra[41] says only thirteen mention the value of relaxation. Of course, you do not confuse the overvigorous, defeatist attack upon a typewriter with orderly, systematic effort. As a successful typewriting student, you apply yourself steadily and with determination. You are at work. But you are not pounding in habits. You are increasing your freedom of movement. Your typing is increasingly a sustained, relaxed following of copy. You give yourself to your typewriter much as a winning ski jumper gives himself to the air.

INTERPRETATIVE SUMMARY

The previous picture of well-poised personality before the typewriter is here translated into terms of muscles. Only with a delicately balanced interplay between muscles can correct typing motions come forth. Here appears another major approach to correct typing, which is a sharp criticism of customary attempts to urge students into an overstrenuous attack upon the typewriter. The key to this fine balance between (*a*) body parts interlocked in support and (*b*) the actual typing motions is the control by partial relaxation of essential muscles. Learning to typewrite depends on learning to relax. A large share of the thinking about typewriting is directed to the discovery of *differential,* or partial, relaxation. This term is descriptive of the different degrees of relaxation for different muscles.

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[41] Debra, F., "An Analytical Study of Present Methods of Teaching Typewriting," Monographs in Education, First Series, No. 9, *Research Studies in Commercial Education,* Vol. III (University of Iowa, 1928), pp. 115–125.

This is made available by the description of ballistic stroking. Improved stroking depends on the student's discovery of how to balance the opposing muscle groups in his forearm and hand. The initial control lies in the throw as a finger is directed toward a key. Starting muscles then relax. Momentum and gravity do the rest. Control is regained when opposing muscles catch the finger to check the stroke and launch the quickest possible rebound from the key, then relax in turn. Later, it will be shown that typing rhythm is controlled by shading this relaxation. This ballistic stroking is possible only when a steady tension in the supporting muscles, known as posture, is just sufficient to afford continuous firmness of support. Such postures are curiously persistent. The loose ballistic motions are firmly supported, yet the entire body is more or less relaxed.

Partial relaxation is to be discovered and practiced. A practical first step is sitting relaxed to the point where copy can only just be read. This "Jacobson Method of Diminishing Tension" is carefully detailed. Stretching muscles to improve relaxation applies equally to so-called finger gymnastics. However, most typing students do not know exactly even the locations of certain muscles supposedly relaxed. To offset this uncertainty, detailed directions from the original illustrations by Jacobson are given for finding these muscle groups, stretching each group to discover the separate "feel" of its "tenseness," and then completely letting go. The relaxation is pleasant. All muscles throughout the body are thus progressively discovered and relaxed. Through such study the discarding of the beginner's awkward and excessive motions is gradually won by relaxing each away. A new and balanced control of copy with the typewriter emerges.

CHAPTER VI

AUTOMATIC CONDITIONING TO TYPING SIGNALS

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READING SUGGESTIONS

To the Student Typist: Read to find out what is meant by your conditioning. Do this by reading chiefly the concrete illustrations of conditioning, pages 104 to 107 and 111 to 128. Catch the disastrous results of any careless practice, page 121. Pass sections such as pages 107 and 108 or 112 to 114, if overdifficult. Note that, as a result of conditioning, typewriting is automatic, pages 124 to 128, and that your motions become easy and flexible, pages 128 to 133.

To the Psychology Student: Learning to typewrite offers so natural, so nearly perfect a demonstration of all that conditioning is that it seems almost as if typewriters were made to order for this very purpose. In this chapter you find a convenient summary of much recent comment on conditioning and numerous illustrations. Simple formulas are also added, pages 112 to 116 and 118. Notice that any practical use of conditioning depends on your insight into its reinforcement. This is identified with gradients, pages 107 to 111 and 132. Notice, in passing, the recent account of forgetting, page 123, and the view of habits as simply preferred behavior, pages 132 and 133. Conditioning is identified also with dissociation, pages 118 to 124. A brief review is taken of the nervous system, pages 129 to 132.

To the Typing Instructor: This chapter, with the aid of its interpretative summary, asks you to exchange any older notions of habits for the principle of automatic conditioning. It features discarding wasteful tensions, pages 103 and 104, and becoming very sensitive, flexible, responsive as a typist, pages 128 to 130. Read to understand what is meant by reinforcement of conditioning, pages 104 to 107, and the need for deliberate changes in your teaching situation for such reinforcement, pages 112 to 116. An instance is conditioning to correct timing, pages 114 to 116. Of special interest is the explanation of discarding errors by withholding reinforcement, pages 123 and 124. Conditioning also is pictured briefly in terms of the nervous system, pages 130 to 132.

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PRACTICE TO DISCARD EARLY TYPING MOTIONS

Since anything you do with a typewriter changes your typing behavior, you will never be quite the same after completing a typing class. If you have ever played at typing by "pecks and hunts" over a keyboard, particularly if in a hurry, probably you are ready to welcome any change. By the time your typing class is successfully closed, your every act of typewriting will be quite different from whatever you were doing or trying to do at the beginning of the course.[1]

In the meantime, the advantages of typing practice lie in your gradual discarding of all that was awkward and excessive. The disappearance of early typing behavior with practice is the most heartening feature of your growth. Learning to typewrite is chiefly dropping, or sloughing off, all beginners' behavior by new "conditioning." Perhaps you guess this is another way to speak of partial relaxation. Are you already relaxing from wasteful tension? Are you the student heir to a teacher who grasps this reversal of the traditional notion of habits? Otherwise, if you are less fortunate, you may be urged to pound fixed habits into your fingers. Or you may be compelled monotonously to repeat drills in order to build up habits; but actually you build up annoyance with the typewriter and all its works. Or such a drill master, instead of helping you discard your present motions, may smile and say, "Practice makes perfect." This trite saying from the recent past represents the timeworn Principle of Exercise. This principle chants that the more you repeat your typing movements, the more they will improve. Really this idea of mere repeating is a very dull one, disowned by former sponsors. Its logical application to your typewriting would mean that even undesirable movements would develop by use, so that actually the poor typist through practice would become a poorer and poorer typist!

Why should you repeat monotonously, when there are ways and means at least a little different? The customary advice that you develop your typing skills by exercise is as plausible as advising Americans in Colorado to pile their mountains higher. Suppose you were to draw a four-inch line with one quick movement. Suppose you practiced this 3000 times. This is surely repetition. Thorndike[2] found that the 3000th four-inch line has not improved. He asserts that, in the light of his extensive experiments, mere frequency of practice may cause as much change in a man as is caused in a telegraph wire by the repetition of a telegram. This is fortunate, for, no matter how many times you repeat a beginner's awkward and inferior motions, you can still drop this behavior.

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[1] Guthrie, E. R., "Conditioning as a Principle of Learning," *Psychological Review* (1930), Vol. XXXVII, pp. 412–428.

Your typing-class situation is full of cues, or *signals*, from instructor and manual, classmates, the typewriter, and your own motions. Refer to these as your *stimulation.* Typing-class practice merely sets a stage for more cues, or signals, than you can possibly count. Of most of these signals, particularly those coming from your own muscles and joints, you are blissfully unaware. Many signals readily bring too many movements. Yet after you are a successful typist, curiously enough, if you could count these multitudinous cues, you would discover far more signals which you have detached and dropped, but far fewer signals which you have permanently attached to your typing motions.[3] Through the changing stimulation called *practice* only the necessary signals finally bring only the necessary motions. All other signals are extinguished as far as your typewriting is concerned, because they are never reinforced, unless by accident.[4] The cutting in of successful movements at last replaces the cutting out of a host of misdirected, earlier motions.

CONDITIONING TO TYPING SIGNALS, AND REINFORCEMENT

After this swift plunge toward *conditioning* signals, you will want to catch your breath and leisurely examine just what conditioning is. Along with American versions of conditioning which you will shortly read,[5–8] you will not want to overlook Hull's[9] story of the beautiful balance which is rapidly forming between starting and dropping typing motions.

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[2] Thorndike, E. L., *Human Learning* (D. Appleton-Century Company, Inc., 1931), p. 14.

[3] Guthrie, *op. cit.*

[4] Hull, C. L., "A Functional Interpretation of the Conditioned Reflex," *Psychological Review* (1929), Vol. XXXVI, pp. 498–511.

Conditioning to a signal is illustrated simply by the classic and original experiment of a great Russian, Pavlov. The most powerful determiner of saliva flow in an unfed dog has always been food. Whenever food was shown, a bell signal was sounded. What do you believe happened? Shortly, saliva flowed at the signal with no food present. Flow of saliva in the dog had been conditioned to a bell signal. You observe that the signal was reinforced by the feeding until built into an essential for saliva flow.

Suppose, however, that the bell signal is unsupported by feeding. Suppose instead that the dog is restrained from food whenever the signal is sounded. What happens? The signal in this situation no longer works.

Do you see clearly from this illustration what happens in your typing practice? Another signal at the same time or just prior assumes the important role of the original signal if reinforced during the practice by the latter.[10] If not reinforced occasionally during your practice, it gradually weakens and even disappears.[11] Thus any typing motion may either persist or disappear in repeated drill. Perhaps you prefer a classic illustration drawn from children rather than from dogs. Mateer[12] fed sweet chocolate to infants and studied the swallowing movements of the throat muscles. To control the infant, a bandage was slipped over its eyes. Eleven seconds later a bit of sweet chocolate was fed to the child. What do you suppose happened shortly? Swallowing movements appeared at the bandage signal even without the chocolate. Swallowing movements had

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[5] Guthrie, *op. cit.*

[6] Razran, H. S., "Theory of Conditioning and of Related Phenomena," *Psychological Review* (1930), Vol. XXXVII, pp. 25–42.

[7] Stagner, Ross, "Conditioned Reflex Theories of Learning," *Psychological Review* (1931), Vol. XXXVIII, pp. 42–59.

[8] Winsor, A. L., "Inhibition and Learning," *Psychological Review* (1929), Vol. XXXVI, pp. 389–401.

[9] Hull, *op. cit.*

[10] Winsor, A. L., "Experimental Extinction and Negative Adaptation," *Psychological Review* (1930), Vol. XXXVII, pp. 174–178.

[11] *Ibid.*

[12] Mateer, Florence, *Child Behavior* (R. G. Badger, 1918).

been conditioned to the bandage. You observe that the bandage signal was rewarded by sweet chocolate until built into an essential signal for swallowing movements.

Suppose the bandage signal, however, is unsupported by feeding sweets. Suppose instead the child is held back from chocolate whenever the bandage signal is slipped over his eyes. What happens? The signal in this situation no longer works. The throat muscles remain relaxed.

If you prefer to draw your illustration from students closer to your own age, consider the apparatus sometimes used in psychological laboratories. A small hammer is arranged to strike sharply below the student's knee, so that the foot jerks forward. A small bell is rung as the hammer strikes. One day the apparatus is left out of order. The bell rings but the hammer fails to strike. Yet what happens? The foot is jerked forward, nevertheless, and cannot be held back. You observe that the bell signal is reinforced by hammer blows until built into an essential signal for this knee jerk.

In typewriting, also, you have been conditioned to the bell signal, which rings close to the end of the line. Several strokes after the bell the type bars lock, abruptly ending the line, so that you must throw the carriage-return lever for a new line. You observe that the bell signal has been reinforced by the type bars locking until it is built into an essential signal for ending your line and throwing the carriage-return lever. It is no longer necessary for the bars to lock. Two or three key strokes after the conditioning bell signal, you throw the carriage-return lever. This reward of success in manipulating your typewriter is your reinforcement.[13]

Really these conditioning signals are even more elaborate. When the bell rings, you "listen" with a series of movements, such as slightly turning the head and tensing the ears. Actually you make your own conditioning signals with these head-ear movements.[14] With practice in which you always set muscles of your left hand to throw the carriage, these very muscles supply new conditioning signals, which displace your head-ear signals. In other words, the conditioning bell signal is probably over in a small fraction of a second. After that, you are responding to your own conditioning signals from your own muscular tensions.[15] The very fact that complicated armies of signals also come from your moving muscles and joints merely means that these are likewise senses much as are eyes and ears. Do not let such automatic refinements of conditioning confuse your understanding of the simple fact of your conditioning to the bell signal.

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[13] Stagner, *op. cit.*

[14] Guthrie, *op. cit.*

ESSENTIAL SIGNALS AS CHANGES OF INTENSITY IN A TYPEWRITING SITUATION

What, then, has been told up to this point? At the outset of your typing studies, you are confused by masses of seemingly similar, mostly useless, signals. That you are overstimulated by these masses of signals is obvious. Indeed, it is very obvious, because the tension of your muscles is excessively high and your motions are excessively wasteful. Slowly, most of these useless signals will drop away by your sheer failure to reinforce them as your typing practice continues. As gradually as unnecessary signals are abandoned, the corresponding wasteful motions are relaxed away. Every muscle fiber not positively needed to support life and your typewriting might better be relaxed.

Cling to your grasp of the idea of conditioning by holding to the concrete illustrations of the bandage signal for swallowing and the bell signal for a knee jerk or for a carriage throw. For you are about to face a barrage of general statements about the intensity of these concrete signals during any given instant of your typewriting.

These essential signals that persist are not the simple cues they seem to be. Your conditioning signals are not simply described, unless you are familiar with the idea of *gradients*. To understand conditioning signals and how each is reinforced, you first should understand something about the direction of gradients.

What are *gradients?* Surely you will not permit so simple a word to perplex you. The term itself is quickly broken into "grade-ient." Consider more or less common annoyances, for example, in your academic work. You are familiar with the "graded" steps of most high-school and college marking systems. Their essential feature to you may be the decreasing annoyance felt in the direction of *E* to *D* to *C* to *B* to *A* "grades." Have you ever felt the pleasant evaporation of anxiety as a *B* or an *A* appeared? What you felt can be called a gradient. Borrow an illustration from the engineer who must control physical forces. You are more or less familiar, for this further example, with the rising and falling "grades" on mountain roads, which call for more power as your car "chug-chugs" along upward or for shifted gears as your car rolls downward. All such slopes of changing activity are called gradients. Even for stupid hens, such graded differences serve as signals. Grain might be thrown upon an ordinary gray ground, for instance, with an added scattering of red grains. Condition the hens by swift punishment to avoid all the red grains. Strange to say, these hens have now been conditioned not to avoid red-colored grains, but to avoid a definite gradient — the sharp change, or slope, between red and a neutral background. This becomes obvious when a red light is thrown over all so that everything — red grains, grayish grains, gray ground — is red. Unconcernedly these carefully conditioned hens will then peck red grains *ad lib.*[16-17] Red grains are no longer avoided because the contrast has disappeared. A gradient, in short, is this contrast.

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[15] *Ibid.*

How do these invisible forces work? To discover the practical importance of typing gradients, you will probably have to think clearly about (1) all typing signals, (2) yourself, and (3) the reinforcement of the signals.

The first general idea is one that is bound to grow in importance to you. It is difficult to state this idea in a sentence. What it amounts to is this — a typing signal would be utterly worthless if it were not for the whole situation in which you met it. For the moment this signal stood out as a special part of the whole incident. Time flashed. Your typing went on. The situation changed. It

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[16] See Koffka, Kurt, *The Growth of the Mind* (Harcourt, Brace and Company, 1924), pp. 138–139.

[17] See Ogden, R. M., *Psychology and Education*, "The Process of Learning" (Harcourt, Brace and Company, 1926), Chapter XIV, pp. 199–280.

will help you to realize that this signal had to be a part of that whole situation if you acknowledge that really you were unaware of any such signal. Probably you were aware only of the total happenings at that instant of typewriting. Literally, conditioning crept upon you unawares.

Why not mull over this general idea while it is reiterated in somewhat different words for three paragraphs? Usable signals, as you noticed in the study of even stupid hens, show some contrast to surroundings. No fragmentary sign can serve as a signal unless it stands out in definite proportion to these surroundings. Such a signal has to stand out with a definite degree of intensity. If you are gradually conditioned to select a dark blue box filled with candy instead of a somewhat lighter blue box that somehow never contains candy, for example, how should you later choose between the dark blue box and a box of somewhat darker blue? Naturally, you select the latter, because your conditioning signal is the ratio — the darker of two blues.

The traditional response of a bull to the waving of a flag also brings out the same point, that it is the relation between the conditioning signal and the whole situation that counts. The dangerous bull is not disturbed unless the conditioning flag is waved in an annoying manner or by a waver who yells, jumps about, or otherwise stirs dust.[18] Guthrie[19] uses this illustration: You are conditioned to the footsteps of a familiar person. You are also conditioned to his face at different distances as that of one and the same friend; also, to his rear aspect as the back of the same friend. Always you recognize his footsteps and his aspect. Yet, at widely different distances these signals are not at all the same. Rather, these signals remain the familiar, contrasting differences that distinguish this individual friend. Similarly, typing signals remain the familiar, contrasting differences which, unawares to you, distinguish successful typewriting.

Since effective typing signals are just such definite fragments of your whole typewriting, you will want to study typewriting in the large. You will want to picture your paper insertion, centering, tabulating, stroking, spacing, and paper removal as a single cycle of typing movement. This is why, in succeeding chapters, you will want to overview the whole typewriting picture. You will want to avoid the older ways of tinkering finger by finger, key by key, word by word, piecemeal. Conditioning is not a piecemeal affair. It is automatic. It can shift multitudes of signals at once to match a sudden change. All you can do is to try out one definite change after another deliberately in your typing classroom, while watching for any improvement in your total typewriting.

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[18] Seltsam, K., "Organismic Psychology and Educational Theory," *Journal of Educational Psychology* (1931), Vol. XXII, pp. 351–359.

[19] Guthrie, *op. cit.*

A second general idea concerns the human brain. Its mechanism makes automatic conditioning possible. It is your center of greatest activity. Marked changes while typewriting influence its activity. New differences between typing signals, naturally, stimulate like changes in your brain. Accordingly, you grow more active. Any such disturbing increase of tension in yourself is reduced by corresponding suitable movements of your typing muscles. Your available outlet for each typing incident, fortunately, is through better typing motions.

A third general idea is now inevitable. It merely explains why the net result is to reinforce each better typing motion. In so doing, it reminds you that everybody is built to move into a steady, comfortable balance.

Your very motions follow whatever direction reduces any disturbance in you. If you are thinking, these motions are tentative, slight, not quite made. If you are typing, these motions actually occur. This is your course of action in typing practice. You change your own motions, during active practice, until your assigned typing task is fully completed and your muscles are relaxed in rest or other steady state.

Successful typewriting practice, then, runs in a popular direction. It becomes a slope of decreasing action. This has already been called a general gradient. It is this successful slope toward the least possible action that reinforces the signals needed to condition fast, accurate typewriting. Such successful typewriting flows naturally from the changes set up in your typing class. In Pavlov's classic experiment with dogs, for instance, you recall that this reinforcing was chiefly with food. Thus the bell signal remains a sign to a hungry dog of approaching food. The bell signal remains a sign of the decreasing action by which this dog eats and relaxes his hunger. If the dog is really hungry, this reward lends the needed reinforcement.[20] Without this occasional reinforcement by food, a bell signal would no longer work. All the essential typing signals, likewise, ought to draw out motions that assure the completion of your typing task. These signals remain signs of its coming completion. Of course, these are not seen like signs upon a highway. What you feel is the reward for your completed task. Yet these multitudes of essential signals, which have crept upon you unawares, have now become signs which should continue to bring out motions needed to reduce your difficulties into the steady state of more skillful typing.

This is all that is meant by saying, "the reinforcement of essential typing signals is by gradients." Perhaps you will catch the point more quickly if you throw out all such terms and simply watch, first, the labored, heavy typing of a beginner and, second, the smooth ease with which an expert lightly breezes through a line of fast typing. Here you visualize, from beginner to expert, an obvious line of decreasing action. Perhaps you would prefer not to use a word like *gradient* until later. Yet it explains the old saying, "Nothing succeeds like success." Sooner or later you will appreciate how naturally each necessary signal is related to the course of your typewriting progress and sustained by each success. Ample reinforcement for workable signals and none for useless signals are keys to your conditioning.

CONDITIONING TYPING SIGNALS GENERALIZED

At this point it may be a relief to turn from general words and statements to concrete signals. Instead of general ideas try general signals; for conditioning signals, too, are quite general.[21] Your dog, for instance, will obey a command which is never quite the same, because spoken in different pitches by a man, a woman, a young child, or yourself.[22] Particularly in typing from rough copy do you require a surprisingly wide range of similar conditioning. Rough copy offers innumerable shades of differences in written language symbols. But this range must not become too wide, or quite different copy, such as *when* and *then*, would be confused. This range is checked at exactly the proper point by not reinforcing.[23] Beyond this point similar signals are not reinforced and therefore disappear. All but the correct typing is relaxed away. For further example, a dog conditioned to a bell of certain pitch will respond in the same way to a bell of another pitch. If this second pitch is not reinforced by food, shortly it will no longer work. The dog no longer responds to both bells, but only to the original bell.

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[20] Stagner, *op. cit.*

[21] Hull, *op. cit.*

If many similar signals bring the same typing response, then your learning to typewrite is a far more flexible affair than is often realized. If you watch an expert typist closely, a dawning suspicion will arise that you watch in vain for the exact and rigid habits that some instructors would ask you to develop.

CONDITIONING REINFORCED BY SUCCESSFUL TRIALS IN TYPEWRITING PRACTICE

Are you interested in gaining one better motion at the expense of detaching so many less desirable motions from signals and losing them — for the time being, at least? Virtually, you throw away many motions to gain one better typing motion. This is the essence of conditioning: your one improved motion becomes either more intense or perhaps catches the signals of the discarded weaker motions. Suppose you represent the signal of your better motion as S and the signal of the weaker as s, yourself as O, your successful typing motion as Rn. As Razran [24] puts it, S–O–Rn becomes either S–O–RN or s–O–Rn. The gradual disappearance of all inferior motions from your practice trials and errors and final success, in terms of conditioning, would be pictured in somewhat this wise by Razran:[25]

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[22] Hull, *op. cit.*

[23] *Ibid.*

[24] *Op. cit.*

[25] *Ibid.*

Let your typing difficulty (S), for example, be connected in varying degrees with possible finger movements (Ra, Rb, Rc . . . Rn). At your present stage of typing skill, one certain motion (Ra) with its conditioning signals is dominant over the other possible motions and in your practice is tried one or more times. This motion, however, is weakened by unsupported repetition. Or this motion might also be blocked by a clashing motion from a stronger signal (Sx). In any event, whether the motion (Ra) is relaxed away or canceled by another motion (from Sx), it weakens and loses its dominance to a second trial motion (Rb) and the (Rb) conditioning signals. The latter motion in turn weakens in your practice and loses its dominance to a third trial motion (Rc). These trials continue until an expert motion (Rn), with its conditioning signals, is hit upon. This successful motion is now reinforced and dominant over all the others — unless by accident an error occasionally should occur.[26]

Mutual canceling of motions is illustrated by a hungry cat in a puzzle cage with milk outside. This cat is already conditioned to attack a restraining bar with skillful clawing. The rigid bar withstands this clever attack and forces a withdrawal. The bar sign thus comes to stimulate an attack and compel a withdrawal, mutually conflicting movements which cancel each other so that nothing happens. The tension remains. The hungry cat searches elsewhere for an outlet from the cage. You may be more keenly interested in opposing typing muscles, since flexors that bend oppose extensors that extend each typing finger. Bend your first finger and straighten it back to see how smoothly these muscles work as a team. The flexor is quicker to start. Do you feel it relax as you straighten the finger? Try to tighten both muscles at once to feel how one locks the other when both are highly tensed. These motions cancel each other. This illustrates the necessity of conditioning opposing muscles until the one relaxes while the other contracts.

Are you familiar with a test for airplane pilots which measures ability to withstand rotating as the prospective pilot sits in a revolving chair? Suppose a student pilot is rotated in such a revolving chair. If he is rotated to the left, his eyes slowly drift to the right. This natural drift of his eyes to the right is interrupted at intervals by a fast jump by muscles bringing the eyes back to the left and toward the usual line of sight. Wendt[27] has conditioned this fast left jump of the eyes to the "ready" signal for rotating. With the conditioning complete, mirrors reveal almost no drift of the eyes during rotation (through 75 degrees). The new conditioning of the eye muscles to a "ready" signal for a fast move to the left has replaced the opposing drift to the right. In the same way you are conditioned to relax one set of finger muscles while the opposing muscles stroke.

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[26] Hull, *op. cit.*

CONDITIONING TO SERIES OF SIGNALS IN TYPING WORD SEQUENCES

Since your practice is the typing of words and sentences in sequence, your conditioning is to series of signals. Ivanov-Smolensky[28] has slowly conditioned a dog to this pattern: a hissing sound (H), a high tone (hT), then a low tone (lT), then a buzzer sound (B). This pattern H–hT–lT–B is always reinforced by the feeding. A slight change in the pattern, H–lT–hT–B, is never reinforced by feeding. Here is the result:

Sequence H–hT–lT–B . . . Automatic Response: 4 drops of saliva in 30 seconds
(7 minutes later)
H–lT–hT–B . . . Nothing!
(10 minutes later)
H–hT–lT–B . . . 4 drops of saliva
(6 minutes later)
H–lT–hT–B . . . Nothing!

Notice that the dog is not aware of a correct sequence or that it is avoiding what to a typing instructor would suggest a "transposed" error in the sequence, even though you are aware of it. Does this suggest to you clearly the automatic conditioning to correct words and phrases for your typing? The incorrect order for the strokes that form a word is not reinforced, and therefore disappears. As the correct order, such as *t-h-e-n* or *w-h-a-t* or *w-h-e-n*, is regularly reinforced during your practice, it persists. The correct series of conditioning signals emerges out of a delicate balancing, which automatically casts off misleading signals that are not reinforced. When you type the word *often*, for instance, the immediately succeeding appearance of *f* reinforces the conditioning for *o*. Any tendency you may have to start with *f* or *t* is not so reinforced. A more remote anticipation, such as *n*, disappears even sooner.[29] During your practice any such errors should gradually disappear. Notice especially that as your typing rate gradually grows faster, hesitation over such false anticipations grows shorter. Pavlov[30] has already demonstrated the value of shorter delays. If you practice from machine dictation, for example, your instructor may keep increasing the speed of the dictation. These gradual increases shorten the delays between conditioning word signals and typing the words. At the end of each practice period, some bothersome anticipation may reappear and interfere as a false stroke when you resume practice. Lepley[31] suggests that your practice trials be widely separated in order to allow for further weakening of these incorrect anticipations before you start each practice upon a sequence (in this instance, *often*).

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[27] Wendt, G. R., "Negative Adaptation as an Active Positive Antagonism," *Psychological Bulletin* (1931), Vol. XXVIII, pp. 681–682.

[28] Hull, *op. cit.*

In short, your typewriting progress is largely making automatic the order of strokes for the more common words. It is well known that both shorthand recording and typewriting become more difficult, or slower and less accurate, with less familiar words and content. Their conditioning signals have not yet been adequately reinforced. Automatic errors still occur through no fault of your own, because misleading signals have not yet been dropped away.[32] Even simple, apparently fixed typing, such as the word *the*, at first shows a mixture of trials of this error and that error in varied sequences. Your typing improvement is finally conditioned on elaborate but flexible chains of shifting signals. The muscle sense signals of one finger's motion help condition the next finger's motion, its signals help condition the third, in a veritable chain, as shown in experiments.[33–34] Of these signals you may be completely unaware. Yet increasingly your motions overlap to form complete but shifting chains on the typewriter keyboard.

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[29] Lepley, W. M., "A Theory of Serial Learning and Forgetting Based Upon Conditioned Reflex Principles," *Psychological Review* (1932), Vol. XXXIX, pp. 279–288.

[30] Pavlov, I. P., *Conditioned Reflexes*, translation by G. V. Anrep (Oxford University Press, 1927), pp. 88–105.

[31] *Op. cit.*

[32] Hull, *op. cit.*

CORRECT TIMING BY SHORT-CIRCUITING OF SIGNALS, CONDITIONING TO DEFINITE DELAYS

The delicate balance between stimulating and holding typing motions in leash is illustrated in Pavlov's experiments. A dog is stroked for one minute, nothing happens for one minute, then dilute acid is put into its mouth. The response to acid is of course a saliva flow. As the experiment goes on, the saliva flow begins to appear before the acid. In short, the response moves forward toward the conditioning signal. An intelligent German shepherd dog has been taught by the writer to do seven acts in a series at his bidding. The commands in order were: "Bring your dish." "Put it down." "Sit up." Speak." "Lie down." "Roll over." "Bark." The dog became so well conditioned to the commands that after months of demonstration to admiring friends the single command: "Bring your dish" would bring forth all seven of the acts in such rapid and unerring succession that it was impossible to utter the commands fast enough to keep ahead of the acts. Later still, the mere appearance of a friend would cause the dog to go through the complete series without command. As such acts move forward toward the conditioning sign, observe that the time is shortened and the useless signals are dropped from the series. This is often called *short-circuiting.*

As your practice continues and you gradually increase your regular rate of typing, a twofold improvement should appear. As each

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[33] Razran, *op. cit.*

[34] Book, W. F., *Learning to Typewrite* (The Gregg Publishing Company, 1925), diagram, p. 131.

finger motion creeps forward toward its conditioning signals, your rate of typing increases. As needless signals are dropped, you type familiar words with a correct ease. Early in your practice, for instance, the useless signals *t*, *h*, *e* disappear, and the merest outline of the sequence *the* is the new signal for your serial typing. Later, in many familiar phrases *the* will drop out and the entire phrase will be typed at once from its mere phrase outline. This dropping out of letter cues and the swifter emergence of complete words will be a common experience as your typing progresses. This short-circuiting will be given a more personal touch when Swift and Towne later describe their learning curves.

How is this short-circuiting, or creeping forward of your typing strokes toward the new conditioning signals, to be properly timed? By practice at gradually rising but regular rates of typing, you are conditioned to this correct timing or delay. An experiment with a half-hour delay shows how this is done. Pavlov first conditions a dog to the beats of a metronome for a few seconds, then a 30-minute delay, then feeding. As you recall from a previous paragraph, many similar signals may now bring the dog's response (in this case, a saliva flow). If Pavlov delays only 5 to 8 minutes, however, no saliva appears. If the delay is only a little longer, there is some saliva. If the delay is just twelve minutes, there is more. After delaying twenty-five minutes, there is still more. With a delay of the full thirty minutes, of course, you would observe the full flow of saliva from the dog. How will you block away any response short of thirty minutes? You already know that this is done by not reinforcing any delay short of a half hour. In time, even a delay of twenty-nine minutes will have no effect. Yet the desired delay of thirty minutes will always bring a full saliva flow, because it is reinforced throughout by feeding. From this simple experiment, do you see clearly why incorrect timing is slowly dropped out of your typewriting if it is not reinforced? Correct timing persists because it is reinforced in your practice at regular rates. Your strokings creep closer to the dominant signals, but they are halted at exactly correct delays between signals and typing. You are both stimulated and held in check. You are stimulated by the copy signals. You are held in check by the conditioning delay. For all familiar words on which the conditioning is complete, the result of this delicate balance is the correct timing of the expert typist. The beauty of this balance is that it is automatic.

You have just read of further application to typewriting of Hull's[35] treatment of conditioning. With his own illustrations and often in his own words, the picture is more clearly drawn of this automatic balance between positive, stimulating signals held in check at the exact instant by signals whose only effect is relaxing. Imagine a rapid succession of such delicate balances, and you have a verbal moving picture of flexible, expert typewriting.

CONFUSED TYPEWRITING DUE TO OVERCOMPLICATED SIGNALS OF OVERDIFFICULT TYPING TASKS

When you are confronted with an obstacle to your typing improvement, there is a rush of increased attempts until you finally chance on a way around the difficulty. This is the usual method of trials, errors, and success. Pavlov has guided fascinating experiments to discover how dogs meet overdifficult tasks.[36] By degrees these experimental tasks are made more and more difficult until the dog's brain can no longer balance the difficulty.

A dog is trained to distinguish between two very similar signals. The first is constantly supported by feeding. The other very similar signal is not. The first signal might be a circle; the second, an ellipse very much like the circle. For example, the first might be four signals in the order H–hT–lT–B; the second, in the order H–lT–hT–B. To the first the dog would answer with flow of saliva and various movements. To the second the dog would not answer.

The signal is then made more complicated. It is continued for several minutes and the dog's response delayed three to five minutes. A strong intermittent electric current is also added. To secure the food, the dog must check its natural withdrawal from this electric shock.

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[35] *Op. cit.*

[36] Ivanov-Smolensky, A. G., "Neurotic Behavior and the Teaching of Conditioned Reflexes," *American Journal of Psychiatry* (1927), Vol. VII, pp. 483–488.

Excited by all these numerous conditioning signals of food and by its hunger, on the one hand, yet blocked by all these numerous, often very similar, restraining signals, on the other hand, the dog's brain proves unable to balance such immediate complications. One must resist the temptation, however, to draw the naïve analogy of a brain as a traffic officer stationed where many streets intersect and manipulating his "STOP" (blocking or relaxing) and "GO" (stimulating) commands until overwhelmed by the press of rush-hour traffic, pedestrians, and fire engines!

Faced in this experiment by too-difficult tasks, the dog reacts to one or the other extreme. Some dogs react to this extreme stimulation with unaccustomed excitement, overactivity of a "protesting" sort. Other dogs react at the other extreme, grow sluggish or relax into drowsiness, and their conditioned responses either disappear or are sometimes weakened for days. New conditioned responses cannot be formed. By presenting too difficult a task, so complicated that the brain could no longer maintain a nice balance, Pavlov has actually demonstrated "nervousness" by experiment. His dogs show typical nervous extremes — either overstimulated, irritable, unrestrained behavior or else blocked, apathetic, indifferent behavior.

This illuminating experiment not only illustrates conditioning to signals, but also suggests in turn how your own brain holds a delicate balance between the stimulating and restraining signals of your typewriting class. If you find yourself becoming apathetic, indifferent, and slow, what cause shall you suspect? May it not be a too difficult task to which, at your present stage of typing, you are unable to adjust yourself? Should your typing assignments, incidentally, be easy, moderately difficult, or very difficult? If your typing assignments are not too difficult, but rather tempt you with just the right degree of difficulty, what other possibility suggests itself to you? Perhaps there are outside difficulties and hindrances in your student life, which abruptly disturb the delicate balance between yourself and your present world. Fortunately, you can restore this delicate balance by temporarily forgetting these outside difficulties.

ERRORS AND LOSSES IN TYPING SKILLS DUE TO NEW CONDITIONING

1. *Retention of your typing skills.* It is, indeed, high time for a hasty review of your conditioning during your typing course. Perhaps such a summary need merely remind you that retention and forgetting are both due to conditioning. Almost any typing class at any time is full of signals. You remain indifferent to many. You adjust yourself, however, to the whole situation at the time. Later, to one or more of the same signals you very likely will adjust yourself as though the entire old situation were present. To one or more little signs in the present, you act as you did days or even years ago when these signals were part of a situation long past.

To the photograph of a best friend whom you have not seen for years, for example, you still react with the same smile you gave him the last time you met. You call this "remembering" your friend. Even the reproduced smile in the photograph could be your conditioning signal. Perhaps you know a certain instructor who is greatly impressed at first sight of a certain student. He gives him unusual opportunities, in fact, goes out of his way to be of help and show interest. Suddenly it dawns upon this instructor that the boy has a smile (let us say) strikingly like the grin of his old college chum. He is following a present signal that belonged to a situation long past. Consider signals that condition avoiding rather than approaching. Suppose that a girl with red-gold hair and a long nose once treated you shamefully. This morning you disliked at sight the new girl with red-gold hair and long nose whom you met. Here is another sign in the present to which you adjust as in the past. Probably you are no longer even aware of the shameful treatment of long ago. Yet its signals are still your cues for acting irritably today towards an inoffensive stranger.

In quite this manner you draw on your past experience to operate your typewriter today. Yet by tomorrow, today will be part of this past. Today's performance on your typewriter itself gives rise to stimulation. Do you already realize how this stimulation may intrude into your future typewriting? Do you begin to appreciate how careless typing over a few careless periods may capture armies of signals away from more successful typing behavior and cause startling tumbles in the test scores of tomorrow and the next day? Do you see why many movements made in the usual typewriting class would be better unmade — that such motions capture signals which must be laboriously unlearned later? Do you discover why there is little or no relationship between time spent in practice and total typewriting progress, why much typing-class time is unproductive, especially if too long continued, why some students improve greatly from a short time of practice while others do not?

2. *Forgetting your typing skills.* Are you amazed at this automatic control of your typing progress by armies of conditioning signals[37] of which you remain mostly unaware? Tomorrow's forgetting, too, will be due to new conditioning which meantime replaces the old.

Your usual conditioning signals, as a result of happenings outside the typing classroom, may no longer work in their old ways; they may even block or interfere with your recent typing behavior. Why? Are you interested in Guthrie's[38] explanation? After you leave your typewriter, what do you do? The bulk of conditioning signals are from your own movements. After you step away from your typewriter, if you make movements at all similar to typing movements you may alienate whole regiments of conditioners at the start and fewer as time passes, down to the last faithful signals.[39] If typing signals recur at times when a different situation excludes typewriting, naturally such signals are detached from typing motions. Away from typing practice, these signals for good typing motions are no longer reinforced. During your waking hours away from the typewriter, multitudes of signals from changes of your position, your movements, or outside sources may have become conditioning signals for quite different motions. Thus a slowly won gain may be lost overnight.[40] When you finally return to your typewriter, your typing may have become shockingly "rusty" or uncertain.

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[37] Guthrie, *op. cit.*

[38] *Ibid.*

[39] Note the similar statement by Skaggs, E. B., "Further Studies in Retroactive Inhibition," *Psychological Monographs* (Princeton University Press, 1925), Vol. XXXIV, No. 161, pp. 56–57.

[40] Stagner, *op. cit.*

3. *Persistence of signals as conditioners of your typewriting.* Nevertheless, a quite remarkable persistence of the multitudes of signals from your posture before the typewriter and from your typing movements, as conditioners of your typing, has been demonstrated by Freeman and Abernethy.[41–42] In this experiment, student typing of a short paragraph with keys covered and keyboard in view is compared with student translating of the same paragraph into number symbols with a key chart in view. Any deterioration of the typing seems actually halted after two weeks. After ten weeks, on the second relearning, the contrast with translating into numbers is startling. Retention scores for the typewriting are actually higher than on the first relearning. Book[43] has given another striking illustration of little loss through time and disuse. After stopping all practice and laying his typewriter aside for nearly one and one half years, he was retested in another series of ten typing tests. Despite this long vacation from the machine, he typed with noticeable ease and a gain of 85 strokes. The actual gain, to be sure, was offset by errors. Book compares 1475 strokes (33 errors) in the closing practice with 1560 correct strokes (51 errors) later. The arbitrary International Contest penalty for errors would have erased both scores. Nevertheless, this is an unusually complete restoration of the old practice situation, as Guthrie[44] would doubtless term it, after virtually seventeen months away from the typewriter. Another psychologist, Swift,[45] has watched typewriting skills persist over long periods with small losses. It is not uncommon for vacations and even longer breaks from practice to have little influence on the effectiveness of the typ-

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[41] Freeman, F. N. and Abernethy, E. M., "Comparative Retention of Typewriting and of Substitution with Analogous Material," *Journal of Educational Psychology* (1930), Vol. XXI, pp. 639–647.

[42] Freeman, F. N. and Abernethy, E. M., "New Evidence of the Superior Retention of Typewriting to That of Substitution," *Journal of Educational Psychology* (1932), Vol. XXIII, pp. 331–334.

[43] Book, W. F., "The Psychology of Skill," *Studies in Psychology* (University of Montana, 1908), Vol. I, p. 75.

[44] *Op. cit.*

[45] Swift, E. A., *Psychology and the Day's Work* (Charles Scribner's Sons, 1919), pp. 137–142.

ing. It is by whatever happens between each practice and its changes in your stimulation, as McGeoch[46] hints, that you may avoid backsliding to errors. After your typing practice is over, if you do quite different things, the forgetting will be less. Fewer conditioners will be lost to similar but nontyping movements.[47]

4. *Discarding errors by withholding reinforcement.* Conditioning will disappear if a conditioning signal is repeatedly given at short intervals without reinforcement. Guthrie[48] thinks this is well verified by common human experience. You have already read of Pavlov's demonstration that, without the support of the food, the bell signal weakens. This disappearance is again illustrated in the case of telegraph operators in small way stations, who place a duplicate sending and receiving outfit in their sleeping quarters. Whether asleep or awake, they do not even hear, much less interpret, the signals that ordinarily go over the wires. They remain relaxed for the major portion of the clicking of the telegraph keys. They are instantly alert to their own "call signals" out of the midst of the similar clicking, since these are conditioning signals regularly reinforced by duty.

If this is correct, then a like monotonous repetition of certain typing errors at short intervals without reinforcement should disrupt the error. With its conditioning signals detached, the error should disappear. Thus an unusually intelligent girl, under Wakeham's[49] guidance, set out to learn typewriting by the latest "touch" system. Early in her work a curious error arose. The girl would repeat the first letter of a given word at the end of the word. For example, *fryf* was written instead of *fry*, *guyg* instead of *guy*. This curious error appeared in more than one half her mistakes on word exercises. Usually it was an *f* that was repeated; in fact, *funny* was written *funnyf* three times. In the corrective practice these words were written *incorrectly* 70 to 100 times: *fry*,

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[46] McGeoch, J. A., "Forgetting and the Law of Disuse," *Psychological Bulletin* (1931), Vol. XXVIII, p. 670.

[47] Guthrie, *op. cit.*

[48] *Ibid.*

[49] Wakeham, G., "A Quantitative Experiment in Dr. K. Dunlap's Revision of the Fundamental Law of Habit Formation," *Journal of Comparative Psychology* (1930), Vol. X, pp. 235–236.

guy, fun, run, thy, gruff, funny. The results were nearly letter-perfect, with only 3 errors in 600 words. Throughout, this girl tried to think that what she was doing was wrong and not to be repeated in ordinary typewriting. When regular practice was resumed, the words *fun, fry, thy,* were each written once incorrectly, but no further errors appeared. Later a curious, converse mistake appeared and shortly caused one third of all her errors. The words *city* (4 times), *mind, funny, thug* all appeared without the final letter — calling doubtless for similar corrective drill.

You will be interested in the further fact that the word *the* had become a conditioning signal to Dunlap[50] for typing the error *hte.* He deliberately typed *the* as *hte* over and over. Naturally, there was very little support from a mere nonsense syllable *hte.* By its repeated typing Dunlap actually extinguished this error.

AUTOMATIC EVERYDAY TYPEWRITING

As conditioning is more or less automatic, your typewriting will seem to improve suddenly, leaving you no inkling as to how you did it. You seem to be getting nowhere, yet suddenly you leap ahead. This is a common though pleasant experience in a typewriting class where conditions have been carefully planned to this very end. Already the most familiar words are doubtless typed without a thought or a care from you. These words at least you now have in common with the expert typist. To this extent automatic regulation of your typing already approaches that of the expert who can typewrite entire pages of copy while his thoughts are elsewhere.

Assuredly, there is no room for alarm or even amazement over this automatic regulation by the most complicated and marvelous machine known — yourself. Herrick[51] has correctly called the plastic human brain, with its almost unlimited possibilities, a thinking machine. In a good motor nerve that carries impulses to arm muscles, for example, from one half to one third its fibers carry signal impulses back to that brain.[52] At almost every point of the body, electrical tension may be constantly changing. Indeed, it is fortunate that you can remain unaware of conditioning signals from your changes of position, from muscles locked by opposing muscles, from your typing motions, since these are countless. By comparison, the typewriter seems an absurdly simple attachment for such an elaborate machine as yourself.

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[50] Dunlap, Knight, "A Revision of the Fundamental Law of Habit Formation," *Science* (1928), Vol. LXVII, pp. 360–362.

[51] Herrick, C. J., *The Thinking Machine* (University of Chicago Press, 1929).

1. *Conditioned, automatic everyday acts.* Reassure yourself by glancing at a few everyday illustrations of automatic motions. Notice the automatic turning of head and eyes toward a sudden noise, such as a loud bell or a sharp command. Notice the automatic control of the right hand. Imagine, for example, a little automatograph.[53] You could rest your hand on its glass frame, which is supported by steel balls, with a writing needle attached. The needle thus registers the slightest movement of a hand. Do you guess that your hand, too, if resting on this frame, could be seen to follow the direction of your eyes? With such slight movements you also, quite unaware, tend to follow a moving stimulus.[54] This little device has been used, slightly changed, to register writing while an entertaining novel is read.[55] If sufficiently distracted, you could write from dictation while reading, feel quite sure that you had been writing, but have no inkling of what. You can be taught certain automatic motions such as *8's*, *m's*, curves of which you are quite unaware.[56] Obviously, automatic writing motions while you are reading an entertaining novel are quite a normal possibility. Automatic drawing or other movements are, too.

From the study of relaxation, you are already familiar with numerous automatic movements made during school hours. Several hundred persons have told about automatic movements in muscles of the face, head, fingers, even feet, particularly during study fatigue.[57] As you try to discover which muscles are tense while you study school subjects, are you successful in noting several automatic movements accompanying your study? [58] Most students have little mannerisms, little automatic motions of stroking back hair, or fingering a button, or twitching this or that, which are seldom observed. Perhaps the most amusing exist in the "absent-mindedness" of some teachers. Try a beginning public-speaking class for plenty of these automatic mannerisms among students. Or at athletic games notice in the stands the amusing gestures which student "rooters" make to help carry the ball down the field, quite unwittingly and without their own consent.

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[52] Jacobson, Edmund, *Progressive Relaxation* (University of Chicago Press, 1929), pp. 266–269.

[53] Jastrow, Joseph and West, H., "A Further Study of Involuntary Movements," *American Journal of Psychology* (1893), Vol. V, pp. 223–231.

[54] Tucker, M. A., "Comparative Observations on the Involuntary Movements of Adults and Children," *American Journal of Psychology* (1897), Vol. VIII, p. 394.

[55] Solomons, L. M. and Stein, G., "Normal Motor Automatism," *Psychological Review* (1896), Vol. III, pp. 492–512.

[56] Stein, G., "Cultivated Motor Automatism," *Psychological Review* (1898), Vol. V, pp. 295–306.

2. *Conditioned, automatic acts under hypnosis.* Perhaps you have taken part in experiments with hypnotism. A college freshman may be hypnotized, for example, and told that he is back in the first grade. He is asked to show how he held the pencil as he first learned writing. Of course, he thinks that he has utterly forgotten such first-grade struggles. Yet, under hypnosis the old situation and its conditioning signals are re-established. This boy will clench his pencil for a struggle with handwriting as in first-grade days. He will describe for you the long-forgotten little girl who sat at his left and the long-forgotten little boy who sat at his right. He seems intensely interested in believing what he is being told. Suppose this boy is now informed that the room is getting chilly and that in three minutes he is to close the window. Such instructions, incidentally, are familiar conditioning signals to a three-minute delay. He is then awakened back to normal. He is no longer aware of instructions about the window, yet what happens? You and the class are convulsed with laughter to see him start to shiver and in exactly three minutes close the window.

3. *Discarding of early language signals and awareness.* Probably these brief assurances that automatic typing is an everyday affair are unnecessary. Probably, as a more advanced typist,

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[57] Lindley, E. H., "A Preliminary Study of Some of the Motor Phenomena of Mental Effort," *American Journal of Psychology* (1895), Vol. VII, p. 491.

[58] Mudge, E. L., "Automatisms in Study," *Pedagogical Seminary* (1920), Vol. XXVII, pp. 99–100.

you recall that you were once too much aware of your early typing motions. Did not a running, silent conversation with yourself accompany much of your early learning? Were you not at first very thoughtful over every finger move? Did you not silently inform yourself what the next stroke should be, what to do and what not to do? You were quite aware of awkward early motions, because of this running silent conversation with yourself concerning them. You resorted to the greatest of human inventions — language signs. You employed these silently spoken English signs as further conditioning signals for your early typing behavior.

Some would say that you were "conscious" of these disorderly, earlier motions. To be "conscious" of a motion, however, very likely means merely that you are able to give yourself a verbal report concerning it. If throat muscles and eye muscles and finger muscles are perfectly relaxed, it would be impossible, as already shown by Jacobson, for you even to imagine typewriting motions.

As your typing progresses, what happens to these slight throat movements silently reporting your typewriting? Indeed, what happened to your lip movements when you were taught to read silently and swiftly in the grades? Your silent reading became too swift for lip movements from which the conditioning signals were short-circuited and dropped. In like manner, these slight throat movements become short-circuited from your finger motions. You are now typing with greater ease. It is seldom that you still require even a silent verbal report made to yourself on your typewriting. Some would say that you are no longer attending to your typing movements. Your typing finally consists of almost automatic motions of which you are no longer aware. Eventually you may not notice even the copy signals that launch your strokings. Your mere intention of typewriting certain copy is holding together the entire operation. Not infrequently an expert stenographer must read what he has typed to learn the content of this material.

4. *Automatic expert typing while performing other acts.* If you are still a beginner in typewriting, notice exactly how much con-

versation you can carry on while typing. None, probably — except with yourself. You are having too many cares to find sociable conversation with vocal apparatus and stroke with fingers at the same time. Virtually your whole body is busy with difficult typing motions.

Can you account for the change in the expert typist? Are not his fingers working while other muscles not directly concerned rest? Somehow hasn't he relaxed away all unessential muscle movements and apparently short-circuited his verbal from his manual movements? Since both sets of movements are thus dissociated after long practice, the expert can operate both sets at the same time. Thus Wiese has conversed in French while typing German chemistry text at 120 words a minute. Or Olga Elkouri, speed operator, has merrily sung or has added correctly ten numbers, while transcribing at a high rate of speed on the typewriter. Even championship typewriting, however, is not perfectly mechanized. The double tasks should not be too difficult. If a clever champion typist is asked questions from an adult "intelligence" test while typewriting at high speed, the answers will not be very successful. Human perfection remains relative. Yet you may have run across a photograph of Stella Willins typing speedily along while riding the sidecar of a fast motorcycle in Birmingham, England. Doubtless you have watched some other trained "touch" typist smoothly typing copy on his machine while he converses with a friend. Eventually, you may be surprised, as a finished typist, to wander away in your thoughts and suddenly realize that another page has been typed. For every practical purpose, the conditioning is then complete.

FLEXIBLE CENTRAL CONTROL OF TYPEWRITING

1. *The nervous system operates as a whole (not by special, well-worn "nerve paths" to typing fingers).* Once it was thought that typing movements become automatic after long practice because it is no longer necessary for the human brain to handle familiar movements. It was thought that such automatic motions are

reduced to simpler levels below the brain. Lashley[59] has shown that this probably is not true. Conditioning is controlled by impulses from the higher centers of your nervous system. It is your human brain that dominates because it is the center of highest activity in your body. In electrical terms, the brain is your center of highest electrical potential.

Once it was thought that you or any student typist wore special, fixed "nerve paths" for each finger-stroking habit. Even yet, many textbooks draw all too neat and simple a picture of how the nervous system changes as you learn to typewrite. Lashley[60] thinks he is close to proving that any simple habit can use not only one, but must use many lines of nerve cells. For example, hungry rats have been trained to weave in and out through a maze of detours and blind alleys, which finally lead to food. These rats have learned a short path through this maze of runways. Lashley[61] has then operated to break a nerve from brain to muscles. With these paths broken, others are used to achieve the maze. In short, as you wrote *the* yesterday and repeat *the* today, you may actually be employing quite different nerve cells in the hookup between your eyes and your agile fingers.

The notion of your nervous system (brain) as a marvelous connection system far more complicated than all the telephone and telegraph wires on the American continents is very common. These connections are really chains of microscopic nerve cells joined to each other by fibers. Such fibers are specialized for speed in conducting "action currents." A fiber from a single cell may run to real length. By a hookup of such fibers in series a "path" might be formed much like a telephone wire. Along such a definite "path," it was once believed, speeds an "action current" from your eye to your brain to your finger muscles. The points to watch in such a hookup (if you follow the all-too-simple analogy and consider yourself a telephone company's "trouble shooter") would naturally be each point where a fiber from one nerve cell connects with a fiber from the next cell. This point is called a *synapse.* In forming your typing habits, it was once believed that by using this particular line, the resistance at these points grows less and less. As a result of this use, it was once believed, your finger could stroke the typewriter key more easily, correctly, and quickly. So vast is this connection system with its millions of hookups, however, that impulses from any or all senses can reach all or any muscles by many different lines of nerve cells.

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[59] Lashley, K. S., "Basic Neural Mechanisms in Behavior," *Psychological Review* (1930), Vol. XXXVII, pp. 1–24.

[60] *Ibid.*

[61] From Lashley, K. S., "Nervous Mechanisms in Learning." In *The Foundations of Experimental Psychology*, edited by C. Murchison. Clark University Press, 1929. P. 549.

2. *Similarity between nerves and typing muscles.* Once it was thought that nerves and muscles are wholly different and separate parts of a body. In your study of relaxation, no sharp distinction has been made between nervous tension and muscular tension. It is now known that any human body operates as a whole, and the corresponding similarity[62] between muscle and nerve is no longer underrated. Both conduct impulses. In other words, along nerve or muscle fibers sweep "action currents" — waves of lowered electrical potential.[63–64] Both nerve and muscle, then, require a very brief period for recovery (a "refractory phase"). In all this, to be sure, the nerve is more rapid. Both obey the all-or-none law. This merely means that the energy of each impulse comes from the fiber and does not vary. Greater stimulation can only start more frequent impulses along more fibers. Both show fatigue, the muscle obviously much sooner. The chief remaining difference seems to be that the elastic muscle fiber is specialized to contract — to shorten, then relax.

3. *Analogy of setting electric switches.* The improvement of your typewriting does not need any slow wearing down of "nerve paths" by repetition. Guthrie[65] suggests that a happier simile is the setting of electric switches. With the switches set, the conditioned signal works — otherwise not. There seems to be no gradual "strengthening" of your conditioning.[66] Either you are conditioned or not.[67] Consider how smoothly and completely the typ-

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[62] Murchison, Carl, Editor, *The Foundations of Experimental Psychology*, "The Mechanism of Reaction" by Alexander Forbes (Clark University Press, 1929), pp. 135–164.

[63] *Ibid.*

[64] If you were familiar with the terms, you could also think of graded ionic concentrations as synapses.

[65] *Op. cit.*

[66] See Wheeler, R. H., *Readings in Psychology* (Crowell, 1930), p. 521.

[67] *Ibid.*

ing of an expert moves over unfamiliar copy. Yet how worn with ruts, like a muddy road in spring, the nervous system of this expert was once thought to be! Few typing instructors will cling much longer to the trite notion of typing skill as worn, fixed paths between letters and finger motions.

4. *Domination by shifting activity patterns in the human brain.* A human brain is too plastic not to show great independence of isolated nerve pathways. It is the whole brain that controls mastery of typewriting skills. No matter what part of a rat's brain Lashley [68] has injured, by way of comparison, its maze-running habit is disturbed in proportion. An injury to any part of its brain reduces its ability to learn the maze and leaves a picture of general inadequacy in adapting to the runways. From your self-study, you can notice hints that point to a similar fact. Have you not observed that in lapses during your speed tests the efficiency was lowered in every respect?[69] Are you not impressed by the ups and downs in the general ease of your typing from day to day? This general efficiency reflects the fact that your brain operates as a whole, and that all its chief areas contribute to your typing habits. By the shifting interplay in your brain between dominant parts and less active parts, a certain serial order is organized. This is an order of relations [70] among the typing activities to follow. It is not in terms of individual typing motions. Typing muscles express the latter.

Can you think in electrical terms of your dominating brain? There are centers of differing activity — of different electrical potential. With centers of differing activity in different parts, should you not expect gradients, or slopes of decreasing activity, between the more active and the less active brain centers? Such shifting brain patterns, doubtless electrical in nature, control typing skill. These patterns become more delicately balanced and flexible with each step in your growth. From these patterns gradients run down to your arm-finger muscles. The customary accounts of the nervous system, as Lashley[71] puts it, seem to provide "an excuse for pictures in an otherwise dry and monotonous text." These look so simple that, as a rule, you could not possibly guess from the picture that the possible patterns are virtually limitless, that millions of nerve cells are regularly involved at once.

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[68] Lashley, K. S., *Brain Mechanisms and Intelligence* (University of Chicago Press, 1929).

[69] Book, W. F., "The Psychology of Skill," *Studies in Psychology* (University of Montana, 1908), Vol. I, pp. 149, 152–153.

[70] Lashley, *Brain Mechanisms and Intelligence, op. cit.*

FLEXIBILITY OF TYPEWRITING HABITS

Shifting conditioning signals and shifting brain patterns, doubtless electrical in nature, are hardly fixed and exact. Why, then, should typing habits be fixed and exact? The answer is simple. They are not. Typing habits are as flexible and plastic as their conditioning signals and their central control within the brain.

Do not be misled by people who ask you to hurry and fix certain typing "habits." Do not trouble to confess if you once planned on nine nice, little habits, one for each finger, with the thumb thrown in, or, because there are forty-two keys, if you once planned forty-two nice little finger habits, each on tap for poking one key. Some typing instructors have actually seemed to want to bind up your fingers with just such rigid fixed stroking by their favorite drills. Such instructors would have bound your hands with invisible bonds much as old-time Chinese parents bound the feet of their daughters, or as rodeo cowboys still rope the feet of calves. It is much easier to untie the rodeo calf than the fingers of the typist victim. Some typing instructors would tie your fingers so tightly to favorite drill exercises that the most confounding confusions will still arise whenever you "advance" to unfamiliar copy. Some instructors would tie your fingers so tightly to separate letters that speed will be forever crippled.

Habit is merely your *preferred* way of acting.[72] Before school, you breakfasted, crossed the street safely, straightened your desk — not one act with precisely the same motions from day to day. Typing behavior is not fixed and inflexible. No expert ever types in exactly the same way twice. "Habit" is another of those blanket terms to be tossed around, catch-as-catch-can. "Should habits be discarded?" asks Bruce,[73] to answer somewhat in this vein:

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[71] Lashley, "Basic Neural Mechanisms in Behavior," *op. cit.*

[72] Tuttle, H. S., "Habit and Attitude," *Journal of Educational Psychology* (1930), Vol. XXI, pp. 418-428.

> Skillful habits with tools and typewriters are not fixed, but rather use a range of flexible acts. Skillful habits mean *special sensitiveness*, so that you are *responsive* to even the slightest changes in conditioning signals. Typing habits are instantly responsive, for instance, to the "feels" of the keyboard, to any weakening in the pace, to the details of copy. Habits are alive, active, a *readiness* to go into action.

Thorndike[74] has emphasized such helps as *identifiability* and *availability*. Soon it is easy to identify the separate keys. It becomes easier to identify the separate words and phrases of the copy. In copy assignments you are now able to identify many cues for the typing movements. Does this not read strangely like *special sensitiveness* to conditioning signals? The same help applies to changes in the availability of your finger responses. The words and phrases and sentences are quickly identified, the finger responses are ready and quickly available. Does this not read strangely like *responsiveness* to conditioning signals? You have long been familiar with these two words: *identify* and *available*. Even the typewriting demon *the*, for example, is now easily identified from other words and is quickly stroked by available fingers. After all, your finger motions follow copy, and copy shows great variety. Motions can be different every day. Keep your finger motions flexible, different, changing. By conditioning your stroking to common words in their sentence setting, you gain not a particular, but a *kind*,[75] of movement.

INTERPRETATIVE SUMMARY

A direction quite the opposite of the older faith in repetition is followed. Learning to typewrite is a matter of dropping away earlier excessive motions as student control grows. This is done by guiding the stimulation. Even the older focus upon the "individual" student is ignored. This student is simply a part of his whole typing situation at the moment. This situation is full of signals from instructor, text, typewriter, classmates, and the student himself. Of most of these signals the young typist is quite unaware, although already conditioned to react to them in ways useless for correct typing. Of course he is confused until literally armies of useless signals shall have been detached from his motions. Overdifficult assignments increase this emotional confusion by complicating the stimulating and restraining signals. The essential new conditioning is won by lending reinforcement only to essential signals. Useless signals, no longer reinforced, no longer work. This discarding applies particularly to the relaxing away of tension in opposing muscles. Experiments are quoted to make concrete this simple fact of limiting reinforcement to signals linked to motions which are successful in the typing situation.

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[73] Bruce, W. F., "Shall 'Habits' Be Discarded in Educational Psychology?" *Journal of Educational Psychology* (1930), Vol. XXI, pp. 479–488.

[74] *Op. cit.*

[75] Bruce, *op. cit.*

This new conditioning extends to entire series of successive signals known as words. Any false succession of strokes, lacking reinforcement, weakens and disappears., For each word, signals bring an automatic series of key strokes that increasingly overlap. Its conditioning is developed, during practice at regular rates, by reinforcing only definite delays between these strokes. The result is a delicately balanced timing, since the stroking is stimulated by the word signals and held in check by the conditioning to delay. It is later shown that practice at definite rhythmic paces does gradually bring this automatic timing of expert typists.

Practice that is too long continued or that lacks incentives, in sharp contrast with the stimulation in successful typing runs, proves detrimental. Inevitably, careless typewriting then captures armies of signals away from the correct motions and brings fatal tumbles in tomorrow's test scores. Just as monotonous repetition of a misspelled word can disrupt its automatic error, so monotonous repetition of a correctly typed word can disrupt its correct typing. When drill languishes to mere repetition, it should cease. A complete rest is distinctly preferable to half-hearted practice. It is true also that similar postures and motions away from the typewriter may detach essential signals overnight. As a rule, however, typing signals are remarkably permanent and quickly reappear after long periods away from the typewriter. If the student does quite different things in this interim, few signals are lost to similar, nontyping movements. Although each student remains mostly unaware of his many signals from correct conditions, supporting postures, and ballistic motions, such ever-present stimulation during the typing practice finally achieves his supply of automatic typing motions.

At this point the older view of a gradual "strengthening" of definite "nerve paths" from the eyes (reading copy) to the fingers (stroking) is abandoned. Automatic typing emerges from the growth of delicately balanced patterns (doubtless electrical in nature) in the typist's brain. These flexible patterns that follow shifting signals are no more fixed and exact than are typing motions. The latter are loose, *ballistic* motions flexibly thrown into any new word pattern.

CHAPTER VII

COMPLETE TYPING PATTERNS

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READING SUGGESTIONS

To the Student Typist: You are asked chiefly to find out what is meant by forming patterns in yourself — especially patterns of common words to be typed, pages 140 and 141, and the pattern of the typewriter keyboard, pages 145 to 147. Next start your study of the finer points in typing, page 150. Study your posture before the keyboard, pages 147 and 148. Consider the "motion feel" in your fingers as a guide to stroking keys, pages 152 to 157. Look for a hint on the advantage of typing whole sentences instead of piecemeal syllables, as in the experiment with the ring-ball game, pages 161 to 164.

To the Psychology Student: Through all typewriting runs a surprising demonstration of Gestalt psychology. Before fast typing can appear, separate strokes must overlap in complete word wholes, or sequences. To study typing is to study both spatial patterns and serial patterns. In contrast with their automatic conditioning, typing patterns themselves are easily observed. Accordingly, you at once meet the Gestalt view of a clear pattern cut out of unimportant ground, pages 137 to 139. This is also illustrated by a musical pattern, page 139, and by time patterns, page 141. Patterns of timing are brought out in mathematical analysis of movements in sports, pages 163 and 164. You will appreciate typical solving of spatial patterns by chimpanzees in Köhler's famous experiments, pages 141 to 143, and of spatial cues by rats, page 144. Glance rapidly over mastery of a practical spatial pattern, the typewriter keyboard, pages 145 to 147. Central control of patterns by the brain is briefly reviewed, pages 151 and 152. An interesting account of the use of senses in the fingers follows, pages 152 to 157. The balance of the chapter is concerned with the controversy between whole *versus* part methods of learning, pages 157 to 164.

To the Typing Instructor: The chapter first seeks to make typing vivid by guiding students to discover its finer points. Better motions should appear through this insight into their essential features, pages 137 to 140. Learning to typewrite is a matter of conditioning new spatial and serial patterns in students. Blending the typist's posture with the spatial pattern of the keyboard is outlined, pages 140 to 151. Central control of all typing patterns in the brain rather than in the fingers is briefly reviewed, pages 151 and 152. Use of a "motion feel" as a stroking guide, except while learning the keyboard, is carefully limited, pages 152 to 156. The importance of timing is again mentioned, pages 156 and 157. The chapter then stresses practice on serial patterns — common words in their line and sentence contexts — as superior to isolated letter or syllable drills, pages 157 to 164.

* * *

SEEKING COMPLETENESS IN YOUR TYPING

You will find this little jaunt into the "wilds" of psychology a challenging experience, and you will be asked to stand by your own independent thoughts and to apply whatever you can to the task of winning your struggle with the typewriter. Typing demands certain motions, and your problem is to supply these motions. Your problem is to find "the one best way" for yourself. Here's hoping you gain a clue here and a clue there to help solve your own sufficiently special problem. You are asked to think in new and unfamiliar terms. You are asked to apply these strange terms to your typewriting. If you cannot do this, the psychology of typing is a mere waste of your time.

1. *Studying new motions as wholes.* You have already been asked, for example, to think in terms of conditioning. The ruthless killing of numerous useless beginners' motions has been stressed in Chapter VI. The stress is now upon the holding of gains in typing skills. You are the more easily aware of new gains because it suffices to observe the new motions as wholes. As your motions become increasingly complete, your typing improves. Since your typewriting yesterday was not complete enough to meet today's assignment, your typewriting today must be more adequate. As your key strokes overlap and disappear into complete words and lines, improvement of the conditioning is automatic. What helps is to be aware of the new completeness of your typewriting. You are now asked, for example, to think in terms of *patterns.*

2. *Cutting definite forms out of unimportant background.* Suppose you treat every typing practice as part of its surroundings. Yet,

at the start of practice, all these surroundings, classroom trappings, and goings on of the typewriting class are rather vague and indefinite — merely background. The jumbled, piecemeal confusion of your first attempts at typewriting might be called a Beginner's Ground. From this indefinite background will emerge definite patterns as the class gets under way. Really, these patterns are clear-cut and solid.[1–2] They may, at times, seem to be built up bit by bit, piecemeal, but later they rather suddenly appear to you as complete patterns.[3] These patterns are conditioned to essential signals. Yet this conditioning, like the patterns which emerge, is an all-or-none[4] affair throughout. It is the reverse of gradual and monotonous repetition. Either you hit upon the essential clues or you do not. Essential features become for you outstanding; all the rest seems unimportant and is properly ignored.

3. *Essential features as typing clues.* You try deliberately to bring out the essential features and the new direction of each typing assignment. Once you' are feeling and thinking about the striking aspects of successful typewriting, once you are checking for these features in your own practice results, you soon start to improve. The more you experiment with a typewriter, the more will the accents be on the right places. Suddenly you see the point:

"O, that's the point!"[5]

You never make this mistake again unless by mere accident. All skills, whether of landing an airplane or high jumping or stroking a typewriter, require this discovery of their special motion patterns. These emerge whenever you catch the essential features. Successful coaches want you to be very definite about these fine points of their speciality.

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[1] Murchison, Carl, Editor, *Psychologies of 1930*, "Some Tasks of Gestalt Psychology" by Wolfgang Köhler (Clark University Press, 1931), pp. 143–160.

[2] See Murchison, Carl, Editor, *Psychologies of 1925*, "An Aspect of Gestalt Psychology," by Wolfgang Köhler (Clark University Press, 1928), pp. 168–179.

[3] See Ogden, R. M., *Psychology and Education*, "The Process of Learning" (Harcourt, Brace and Company, 1926), Chapter XIV, pp. 199–280.

[4] See Powers, F. F. and Uhl, W. L., *Psychological Principles of Education* (D. Appleton-Century Company, Inc., 1933).

[5] Köhler, W. in C. Murchison, Editor, *Psychologies of 1930, op. cit.*

4. *New patterns cut out of typing practice.* Do you not find something quite dramatic in these clear-cut patterns which result from your more-or-less confused early experimenting with the typewriter? Life moves in the direction of such new ways, created by whatever act completes each pattern. Perhaps certain spatial relations are cut sharply out of the typewriter keyboard. Perhaps a certain rhythm or a certain word fingering is cut sharply out of other vague possible movements. Perhaps you cut clearly out of this indefinite ground the new and definite stroking pattern, *an;* perhaps you clearly catch the new and definite stroking pattern, *other.* Suddenly you have merged them both into a new whole, the new and distinct sequence *another.* Again, out of the ground of possible strokings you cut *yours;* also, *truly.* Suddenly you merge them both into the new correspondence-closing sequence, *Yours truly,* a different and distinct whole.

Perhaps a difficult spatial relation on the keyboard, or a certain faster rhythm to which you have hitherto been indifferent, is suddenly understood as a clear-cut pattern. Incidentally, it is your understanding that now makes it possible for you to speak and tell yourself or others of this new feature.[6] This shows how your understanding becomes part of the typing situation. For you to type exercise after exercise of which you have no understanding would be an absurd waste of time. Perhaps the chief point in such a pattern would be "pleasing the instructor" or "getting by with a grade." Practice in forming such patterns has little to do with typing habits. By contrast, out of the jumbled, awkward ground of possible typing motions you are to cut essential new movements.

5. *Whole musical melodies as sample patterns.* You have on occasion worked with obvious patterns, during high-school days, by practice in the school woodworking and metal shops; or, if you are a girl, by making your own dresses or costume designs in some school workroom or studio. Nevertheless, to think of all your college and school work as series of *patterns* may seem a new notion.

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[6] Scott, R. R., "Some Suggestions on Learning from the Point of View of Gestalt Psychology," *Journal of Educational Psychology* (1930), Vol. XXI, pp. 361–366.

Any number of agreeable samples of whole patterns may, of course, be borrowed from music. If a melody of six or less tones is played and then immediately played over with but *one* tone slightly raised, the entire melody probably seems higher.[7] The longer the melody, the better you will catch this pattern effect, especially in its middle tones. Tones before the altered note are influenced more than the later tones. If the melody had not emerged as a whole from earlier experience, such effects from a mere semitone change would be impossible. The shape of a melody as a whole gives you pattern effects. You will find similar samples of time patterns in your recognition of a melody played at different tempos, even in different keys.

6. *Word and phrase sequences as patterns.* In typing, you are writing words in sentences — following copy. Glance twice at the words you are now reading and ask yourself: Are these words patterns? Are these patterns with definite proportions? Take the very word *pattern*, with its seven letters spread in their definite order, or sequence. Doesn't it suddenly emerge for you as a more definite, clear-cut figure? Do you catch the definite relations between its letters? Does each letter strike you with a little different intensity? Obviously, its letters are spread over three quarters of an inch of space. As you read, doesn't the word exist in time? If you are a rapid reader, of course, you could have caught the whole word in a fleeting glimpse of the barest outline of its form and proportions.

In a fresh approach toward this study of patterns, suppose you examine three words: *dear*, *not*, and *week*. These are common but very simple patterns of typing. Contrast these patterns with *began*, *doubt*, *effort*, *experience*, *organize*. Each is a quite difficult pattern of typing motions when stroked upon the common keyboard.

Later you are copying a letter and reach the phrase: *With best birthday wishes.* As your eyes pause here and there to read, this becomes a time pattern. It is to relations in and between these four words that you react. Obviously, this phrase is strung out along the line in a spatial pattern. It is the proportions of its skeleton outline which are essential. Your copy might be in many possible positions, such as beside the machine or above it or otherwise. With the eye fixed, the phrase from each of these different positions would stimulate different points in the back of your eye. Yet its pattern is evidently independent of the particular points excited in you. No matter what particular nerve cells are stimulated, you would still type the phrase: *With best birthday wishes.* The problem of acting upon such definite proportions seems to underlie all typewriting behavior. The final common paths to your fingers are sensitized to such ratios within patterns.[8]

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[7] Guilford, J. P., "Some Configurational Properties of Short Musical Melodies," *Psychological Bulletin* (1931), Vol. XXVIII, p. 700.

STUDYING THE WHOLE LAYOUT OF SPATIAL PATTERNS

1. *Typewriting as an event in space time.* Sitting before your machine the typing situation itself is a spatial pattern. There is the workroom, your solid typewriter, your solid self — height, length, width. Typing movements are successive in the fourth dimension — time. With every line you type, you are able to note that typewriting truly moves in this fourth dimension. Really, time is distance, since officially it is measured by the swing of a pendulum over a definite path. Here it is chiefly in the swing of type bars and progress of the carriage. Were you a university student who wished to dream to far-flown reaches of science, you might discover that space and time are one, that typing is an event in space time. If you enjoy such flights, perhaps you prefer the company of Einstein to your fellow typists. Most typists are content to take space time for granted and talk of finger motions instead of patterns. Simple, everyday spatial patterns, however, will not tax anyone. .

2. *Sample chimpanzee solutions of spatial patterns.* The spatial patterns to which a brain is adapted are dramatically pictured by Köhler.[9] He does this by watching chimpanzees. If you could

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[8] Lashley, K. S., "Basic Neural Mechanisms in Behavior," *Psychological Review* (1930), Vol. XXXVII, pp. 1–24.

[9] Köhler, Wolfgang, *The Mentality of Apes* (Harcourt, Brace and Company, 1927), pp. 229–234, 252–256.

only see his motion pictures of chimpanzee behavior, your insight into spatial patterns would deepen. Next best, perhaps, is for you to examine a problem and its solution in terms of a spatial pattern:

Nueva is a mild, friendly little chimpanzee, with an extraordinarily broad and ugly face. Nueva is behind her railing. Just beyond is a square drawer with bottom and one side knocked out. The open side, as you see, is farthest from Nueva. First she tries hard to pull the banana up towards her with the stick. The stout box side continuously prevents this. Nueva grows greatly distressed. Suddenly she changes, puts the stick in front of the banana, and starts pushing it with little jabs away from herself. In this manner Nueva pushes the banana out through the open side and at last around into her reach. To solve this spatial problem, she has to break natural resistance against pushing a much-prized object away from herself. Indeed, to push away something that you prize seems absurd. Yet, when you consider this as part of the whole spatial pattern, Nueva's solution fits perfectly. This sudden appearance of a complete solution with reference to the whole layout of the field is called by Köhler *insight.*

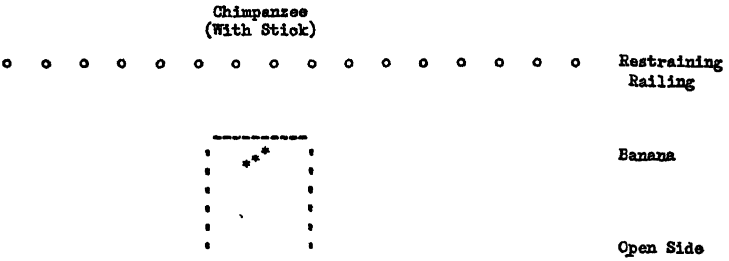

Figure 2. Spatial Pattern of a Problem Faced by a Chimpanzee (From Köhler[10])

Do you wish to sketch a spatial pattern solved perfectly by

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[10] Köhler, Wolfgang, *The Mentality of Apes* (Harcourt, Brace and Company, 1925), p. 240.

Sultan in three trials? To include the complete pattern of motions, you should show both (1) Sultan's use of a tool (stick) in a direction away from his immediate desire and (2) the essential change by this chimpanzee from one spatial position to another that is quite different.

Here is a big wooden cage with Sultan outside. One side is of bars. All other sides are boarded up tight. Only in the closed side opposite to the bars is a gap. This gap in the wall is too high for a chimpanzee's arm reach downward to the banana just beneath, yet wide enough for prodding with a stick. The single available stick is tied to a convenient tree so that Sultan can use it only through the gap.

This chimpanzee soon prods at the banana below, trying vainly to lift it high enough to seize it. All at once he starts pushing it carefully away from himself, but toward a little knothole in the middle side wall. He makes a mighty squeezing effort with his fingers, but the knothole is too small. He prods a bit, drops the stick, and runs around to the bars to try reaching. By chance, the banana has come just far enough. He succeeds. Next, with a new banana and a new trial, Sultan simply ignores the knothole, pushes the fruit right up to the bars (way into his possible arm reach), and is immediately running around to snatch the prize. Again, with a new banana and a third trial, he tosses aside his stick and runs the moment the fruit arrives at comfortable reaching distance from the bars. As with Nueva, to push a prize away from himself seems a stupid error until it is viewed in the light of the complete solution which emerges to fit the whole situation.

3. *Spatial proportions as essential signals.* Another striking animal illustration of the spatial relations to which a brain is adapted comes from Lashley's[11] experiments. A rat is trained to patterns of solid white on a black ground. It is then shown a pattern of solid black on a white ground. In either case the rat acts in the same way. A rat is trained to a certain outline. It is then shown fragments of the outline (in the same proportion) or a solid figure having the same outline. In all these cases the rat acts in the same

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[11] Lashley, K. S., "Basic Neural Mechanisms in Behavior," *op. cit.*

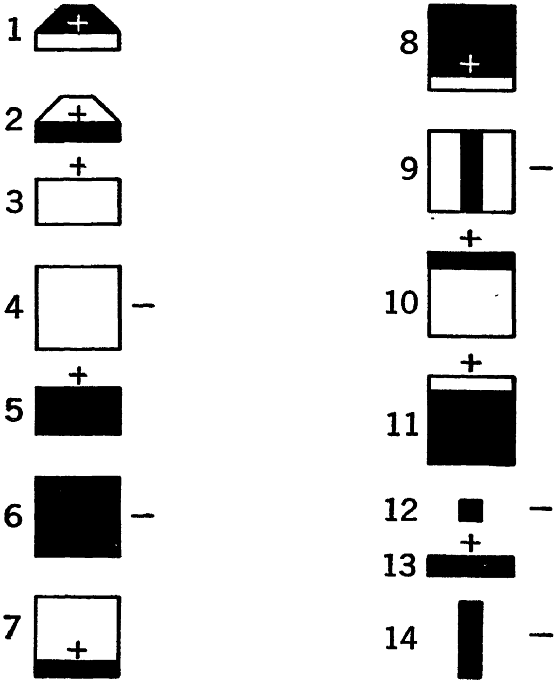

Figure 3. Equivalent Spatial Cues for the Rat in Jumping

Animals were trained to jump to a platform having the appearance of 1, seen against the background of the room. The following figures were then presented in succession. The + sign indicates the position to which the animals jumped promptly; the — sign indicates failure to jump in five minutes. (From Lashley[13])

way. From the illustration you will readily note the kinds of spatial signals which rats "generalize." Lashley[12] has trained rats to jump to a platform with a black surface and white edge. As its appearance is changed (Figure 3), the rats continue to jump to any horizontal rectangle, whether white or black. You observe that these patterns have in common only similar proportions.

[12] From Lashley, K. S., "Nervous Mechanisms in Learning." In *The Foundations of Experimental Psychology*, edited by C. Murchison (Clark University Press, 1929), p. 543.

[13] *Ibid.*

Later, as you grow acquainted with the Gilbreth motion studies, you will decide that the Gilbreth motion pictures and motion models have one purpose — to make the spatial and time patterns of correct typewriting visible to you and others with like definiteness.

SPATIAL PATTERNS OF THE TYPEWRITER KEYBOARD

1. *Organizing the whole keyboard as a pattern.* Touch typewriting is an organized spatial field. Here are spatial patterns for you to solve and utilize on any day that you use a typewriter. When you glance curiously at either the "simplified" or the "universal" typewriter keyboard, what is your first impression? Is it the *u* key or the *a* key on the one, or the *f* key or the *a* key on the other?[14] Or is it a pattern of forty or more keys arranged in definite rows? The whole keyboard is at once a definite pattern. Moreover, it is the *whole* keyboard which you are to operate. It is to exactly such patterns, four rising rows of from 10 to 11 keys spaced in definite proportions, that the human brain is adapted.

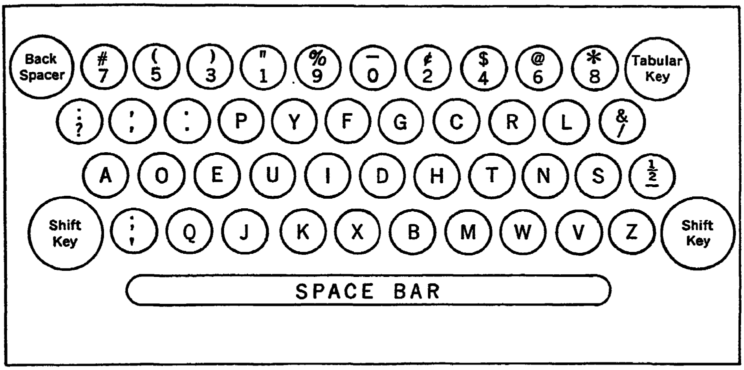

Figure 4. Dvorak-Dealey "Simplified" Keyboard Arrangement

When you place your fingers upon the home row, *aoeu htns* (or *asdf* and *jkl;* on the old keyboard), these spatial relations are so obvious that the veriest tyro cannot miss them. Reach your fingers to the row above. What automatic conditioning signals in muscles and joints do you guess accompany such motions? From *a* to *?* (or to *q* on the old keyboard) your fourth finger has reached or stretched in a very definite direction over a very definite proportion of space. All the other fingers reach or stretch with like definiteness. Reach your fingers to the row below: *'qjk mwvz* (or *zxcv m,./* on the old keyboard). What automatic conditioning signals do you guess attend these motions? From *a* to *z* your fourth finger has reached or stretched in definitely the opposite direction over a definite proportion of space. All the other fingers reach or stretch with similar definiteness, felt in muscles and finger joints. Whatever tenseness you feel reflects these motions forced by the spatial relations of the whole keyboard. Therefore it is these *relations* or invisible slopes between all the keys which are the *pattern of the keyboard* and determine Good Form in Typewriting.

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[14] See "Typing Motion Studies," Chapter X, pages 240–283.

Thus you "learn" the relations of individual keys to the whole keyboard. Writing individual keys alone would never be present-day typewriting. Indeed, the positions of various keys can be shifted without injury to the learning if the new pattern of the changed keyboard is kept throughout the learning. The learning proves superior whenever the new relations are better balanced than in the wretchedly arranged pattern of the present "universal" keyboard. It is a misnomer to refer to the traditional keyboard as "standard" in any way except that of general use or stupid precedent. Whether the "simplified" or the "universal" keyboard is used, each individual key is of small moment. Any convenient mechanical device would do as well for any typist if the pattern of the keyboard kept the same spatial relations. Should you organize this pattern by first adapting to the home keys, then gradually, section by section, experiencing the new reaches or ratios to other keys? Such more-or-less piecemeal methods, starting with the home row (horizontal) or with single fingers (vertical), are common. Yet in classes compared by Long,[15] learning the keyboard *as one whole*, while skipping around to type a word or sentence, brought distinctly faster test scores. Learning the keyboard as a whole was 10% superior in bringing the right finger to the right letter key. With a simplified keyboard, by contrast, so many beginning sentence exercises lie under the fingers, as they rest in a natural position above the home row, that the ability to locate other keys naturally expands as the demands increase.

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[15] Long, N. C., "An Experiment with the Relative Efficiency of Various Methods of Teaching the Typewriter Keyboard," Monographs in Education, First Series No. 11, *Research Studies in Commercial Education* (University of Iowa, 1929), Vol. IV, pp. 34–39.

Even if at first you hunt for unfamiliar keys with your eyes, you see more than the key that you pursue. You also feel more than the tenseness of each reach to an upper or a lower key. You feel the tenseness of each reach to a different point of the whole keyboard in its ratio to all the other reaches. In spatial terms, you feel your way into the inclined plane slanted over the four rising banks of keys. You are finding the position so finely pictured by Smith and Wiese,[16] with the muscles so nicely relaxed, yet balanced, that the arms seem "to float from the shoulder down," the *upward slope* of arms, of vaulted hands, of arched but relaxed fingers ready to stroke *in the same inclined plane* slanted over the four rising banks of keys.

2. *Typist's posture blended with the keyboard pattern.* In order to hold this balanced spatial pattern, you must take an identical position before the keyboard each time. Any change in your typing position will break the delicate balance which you are creating between yourself and all the keyboard reaches. Any change will help also to disrupt your automatic conditioning. The very slope of the keyboard sets the typing posture, while the length of your upper arm sets the height of the typewriter table. In this way, the elbows are below the point of typing, so that from each inside elbow to the joints between hand and fingers your forearm, wrist, and hand form one continuous slope parallel to the slope of the keyboard. Despite finger reaching to outer keys, the top row of joints, like a hinge between hand and fingers, should remain quiet, even, and parallel with the keyboard. Holding the hand forward as part of one continuous slope insures that the middle-finger joints remain practically vertically above the home keys. This easy, balanced

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[16] Smith, H. H. and Wiese, E. G., *Seven Speed Secrets of Expert Typing* (Gregg Publishing Company, 1921), pp. 11–14.

fit between posture and keyboard is necessary in order to launch the rapid, loose, momentum stroking known as *ballistic*. It is this persistent posture which makes such light, staccato stroking possible. This virtual matching of keyboard with posture is easily demonstrated by setting the typewriter at an incorrect height and thus destroying the balanced forearm slope.

When Klockenberg [17] has experimented with raising or lowering the keyboard well above normal position, the speed losses have proved surprising. Key strokes per minute have dropped approximately one fourth. Thus, a typist has dropped from 314 key strokes to 227 with the keyboard too high, and 230 with the keyboard too low; another typist, from 256 to 199 and 195; another, from 271 to 186 and 208. As a further illustration of change in posture, suppose that you start to press your upper arms closely against the body. With such a change Klockenberg has found a 9% loss in speed. Naturally even world champion typists are greatly upset if the chair is too low or too high or if the typewriter is moved on the table or similar definite spatial relations are disturbed.[18] Seemingly minor details are important. Observe how the vertical rows of keys climb to the left and, finally, at the numerals switch to the right. These vertical steps are fairly awkward. Maybe you can compensate for this in part by sitting slightly to the right. On the old keyboard, in particular, you thus afford your overloaded left hand a little more ease. The importance of planning a firm, yet relaxed, persistently alert posture simply reflects, for you, the fact that it is the *whole* typist who types. Back of all *ballistic* stroking must be this balanced body. In short, when excess errors, fatigue, depressed "blues," excited tension appear, check for lapses in this balanced fit between yourself and the keyboard.

Perhaps you can bridge the gap between the uncertain posture of the beginner typist and the firmly balanced posture of the champion typist. Can you imagine yourself transported for the moment to the Gilbreth motion-study laboratory? Catch the mutual give-and-take in motion-study experiments. Then study your own position as your hands and the typewriter form a single pattern.

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[17] Klockenberg, E. A., *Rationalisierung der Schreibmaschine und ihrer Bedienung* (Julius Springer, 1926), pp. 30–49.

[18] Book, W. F., *Learning to Typewrite* (Gregg Publishing Company, 1925), p. 179.

3. *Gilbreth motion-study notes: typing posture.* Let us listen to a short conversation about posture in the Gilbreth laboratory.

Speed Coach. We should obtain a chair of the proper height. We must take into consideration the stature of the person. Hasn't the position of the spine an effect on the typist?

(Chair and machine are adjusted to the correct height. Regular one-minute demonstration with the typical test stand. Machine, four years old. Last time, when the typist did not have it, she was greatly hampered by not having her own machine.)

Mr. Gilbreth. It is rather interesting to see how much the typist's nose moves in comparison with the cross-sectioned background.

Speed Typist. When the machine is not held still, the keys all collect.

Speed Coach. This typist has a better position at the keyboard than the other operators. There is very little forearm movement. The shoulder is the slowest, the elbow next, then the wrist, then the fingers.

Mr. Gilbreth. I want to have these girls hold their hands in the position they think they do, and then show you some pictures of the way they really do.

Speed Typist. I eliminated much loss of time after I left school and went to work.

Mrs. Gilbreth. Did you have to hold your arm or wrist in any set position?

Speed Typist. I had to have my fingers in a set position and think of the keyboard first.

Mrs. Gilbreth. I notice differences. Is it a matter of personal choice or a matter of teaching?

Speed Coach. A matter of teaching. Resting on the keys is apt to cause hesitation and error. The fingers should be about an eighth of an inch above the keys. I have eliminated the up motion. If you hold your wrist down, you are ready to pounce on the keys at all times. . . . With some the wrist is not supposed to move. The wrist is only to put the hand in position. The majority of people work from here. It is a question whether you would tense the muscles of the wrist or not. The operators who use wrist action have never had neuritis.

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Typist (after taking off his coat and typing with shirt sleeves rolled up to show the motions of his wrist). We all have to wear glasses because we are used to having the notes flat on the desk.

Mr. Gilbreth. Your copy ought to be squarely on the line of sight.

Typist. We incline the head so as to make it nearly square with the line of sight.

Mr. Gilbreth. You are mistaken. To be square that board would have to be like that. (Readjusts copyholder.)

Typist. Then the top line and the bottom line are not in the right place for focus.

Mr. Gilbreth. The best is to be square with the middle line, and be off a little on the top and bottom. It is a little off as the eyes go up or come down. If I were going to do that, I think I would have a copyholder curve so that everywhere the distance might be the same.

4. *Complete spatial patterns set the finger motions.* In your typing studies, your fixed position becomes part of the total keyboard pattern. You are gaining by these new insights a complete spatial pattern by which you can use any finger strokings directly in new copy settings.

This approach may be made even more striking by this unexpected suggestion. When in the midst of your typing struggles the total keyboard rather suddenly emerges for you as a definite pattern, your fingers are of minor account. Perhaps you have already guessed this by looking over the amusing assortment of hands in your own typewriting class — all kinds of fingers, fat and lean, tiny and enormous, possibly a few partly crippled by injury. To compare drawings of the hands of many typing students is to toss them aside as having nothing to show about typewriting ability. Here is an excellent typist whose left hand was badly burned and mistreated in childhood. You are startled to see the twisted third finger with its limited motion. The startling fact is that this typist produces a fast and accurate output. If you would extend your own observation, compare the hands of two champions. Watch the heavy, powerful fingers of George Hossfield racing evenly with the long, tapering fingers of Albert Tangora.[19] Fingers scarcely

[19] Compare the hand photographs in Stuart, E. R., *Stuart Typing* (D. C. Heath and Company, 1932), p. 3.

count in typewriting except as necessary tools, because fingers do not organize their own motions.

CENTRAL CONTROL PATTERNS

Any finger strokings can be thrown directly into new sentences by activity patterns, presumably electrical, organized within your human brain. In the same way in conversation you throw a new word into the correct pattern or grammar of spoken English.[20] You may be quite unaware of the underlying grammar, yet you use the word correctly. The framework for your typing must exist in the brain. It is probable that its complete patterns are maintained as "mental" attitudes which are self-regulating. It is to be hoped that these attitudes reflect the best typing-class conditions yet devised. It is probable that your fingers, no matter what they do, have little, if any, influence upon any dominating central attitude. Why dominating? Because your brain remains the center of highest activity — expressed in electrical terms, the center of highest electrical potential — in your whole body. From this center the chief gradients of changing activity slope to your typing muscles.

Central control is nicely illustrated in an experiment by Jacobson and Lashley.[21] On an ape's brain these scientists have mapped the area giving muscle movements, the motor area. Then they have excited the proper brain point so that the fingers extend. The finger extensor muscles, as you know, extend the fingers outward. At the same time they have changed the positions, or posture, of the limbs, head, and body; they even have stimulated these electrically. Nothing important has happened. The fingers have kept on extending regularly despite all these outer changes in limbs and body. By contrast, Jacobson and Lashley have next excited another distant point in the motor area of the ape's brain. This has changed the movement to bending of the fingers. The finger flexor muscles, as you know, bend the fingers inward. Again, the positions of the limbs and body have been changed repeatedly. Yet the new movements have persisted. This seems to demonstrate finger control maintained from the brain despite anything that happens to your hands.

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[20] Lashley, K. S., "Basic Neural Mechanisms in Behavior," *op. cit.*
[21] *Ibid.*

The human brain, with literally millions of nerve cells, is complicated beyond the scope of your imagination. This can be demonstrated by any mathematician. The brain is the most flexible, delicate machine ever known for translating patterns into finger motions. If you will agree that words, phrases, even sentences are definite patterns, the path to typing is open. For the human brain is developed exactly to balance words. Your many senses, your human brain, your typewriting muscles can thus be unified into one whole, which is *you*, typing.

TYPING PATTERNS OF MUSCULAR TENSENESS AND TOUCH

1. *Touch and "motion feel" as guides to stroking patterns.* Can spatial patterns, obvious in a glance at the keyboard, be felt as shifting strains at the finger joints, as tenseness of the fingers, as touch with the finger tips? There is no doubt about the answer. These changes in the fingers, especially if you try to improve their clearness, can be felt fairly well. Resistance from each key helps in this. A key stroke may be made with many different degrees of force even when a typist strives for evenness. This force, or intensity, of the key stroke may differ greatly for weaker fingers, for awkward stretches, for upper keys in one direction and lower keys in another, or for hurdles across the home row. These different degrees of activity in stroking form patterns having definite proportions, to all of which the brain is finely atuned. They furnish multitudes of automatic conditioning signals.

2. *Neutral vagueness in feelings of tenseness.* Whether these so-called "motion feels" are a safe guide to your typing improvement is quite another question. You have only to tighten a finger muscle to observe that the "feel" of muscular tenseness is a vague and neutral affair. The vagueness of this proffered guide can be illustrated from music. As you listen to fascinating music perhaps your breathing quickens, you consume more oxygen, the circulation of

your blood is quickened, and your throat muscles probably hum the melody silently. Not a few leave a concert hall with tired, dry throats. Immeasurable bodily changes happen, yet what your feelings tell you is very diffuse, not at all clear or different. You simply "feel" favorably or unfavorably about that music.[22] Can you "feel" most of the time much more than favorably or unfavorably about the evenness and lightness of your typing?

What happens if you elect as your sole guide the "feel" of the key-stroke motions is nicely forewarned by Warden's [23] sixty students who learned to trace through a simple maze by their hands alone. Indeed, the paths through this little maze and all its detours and blind alleys were hooded out of sight under a black cloth, much as typewriter keyboards are sometimes overcautiously hidden with an apron or a shield. These sixty students learned to trace the right path as a whole with a stylus by the "touch" system in some seventy trials. Each then drew a spatial diagram of the maze entrance and of the goal finally reached in the maze. Of 240 drawings, the size of the maze was overestimated in 165, or 68%, and doubled or estimated even more than twice the true size in 15%. Two thirds of these university students were not able to draw the simple L-form of the alleys of the maze which each had been through some seventy times. There were ten of these little alleys, yet 9 out of every 10 students felt there were less. The maze seemed much larger, in the drawings fully six inches larger, than it actually was. Each student usually expressed great surprise when shown the maze after learning it correctly by the "touch" system.

Another interesting sample of the "motion feel" as a guide is supplied by a student who astonished the psychologist in charge.[24] Before this student was a wide sheet of paper. From one vertical edge of the sheet, a line ran off at an angle and disappeared toward the other edge. On the other edge of the sheet, without looking, the student would mark the point where he felt the extension of this line ought to pass. With practice, the errors of this student increased alarmingly. Note that his sole guide was the "motion feel" from arm and hand as he estimated and marked a point. Finally, in despair this student confessed that he felt he was underestimating the proper point, therefore would always push it over to compensate. So much for the "motion feel" as a sure guide in estimating location of a point or a key.

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[22] Kwalwasser, J. A., "Music Appreciation: Is It Vital?" *Music Supervisors' Journal* (1930), Vol. XVI, pp. 13–17.

[23] Warden, C. J., "Judgments of Certain Space Relations Based upon the Learning of a Stylus Maze," *Journal of Experimental Psychology* (1925), Vol. VIII, pp. 399–407.

[24] Spencer, L. L., "The Effects of Practice without Knowledge of Results," *American Journal of Psychology* (1923), Vol. XXXIV, pp. 107–111.

3. *Self-guidance of beginner typists by finger "motion feels."* There is a well-known manual[25] of touch typewriting which advertises a "kinesthetic" method. This term merely refers to muscular tenseness. Since actual typing is by finger muscles according to all manuals, the term is happily superficial description. Its stress, however, has proved to be a real contribution to typing practice. Students are doubtless impressed when urged to develop their "kinesthesis" by following every "motion feel" in typing. Coover[26] might demonstrate "letter kinesthesis" by asking you, also, to raise your right hand and hold it back out of sight. You watch his hand similarly held. He commands, "Do this!" and bends his forefinger. You do the same. "Did you do it? Are you sure? How do you know? Now, again!" Again you bend your forefinger. "Now, how do you know you did it? You didn't see it."

"I felt it," you reply. Then you raise your left hand and hold it back out of sight. You bend this left forefinger.

"The feel of that stroke is *f;* now, again, *f-f-f*."

In like manner you are drilled on the strokes for all the letters on the home bank, until in a few minutes you readily bend unseen fingers to all the letters called in random order. Obviously each motion is readily located as to its particular finger.

Through magic of repetition, apparently, seeing the letter form and feeling the letter movement are then to be "welded together" as one so that the letter becomes the "feel" of the finger movement.[27] Of course, mere repetition might accomplish little, but the lively description evidently catches the interest of any beginner and adds real direction to this learning.

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[25] Wiese, E. G. and Coover, J. E., *The Wiese-Coover Kinesthetic Method of Learning Touch Typing* (H. M. Rowe Company, 1924, 1927).

[26] Coover, J. E., "Principles of Learning in Typewriting," *Rowe Budget* (1928), Vol. XXX, p. 11.

From this promising start, the "motion feel" is quickly elaborated into a lively tale of the Princeton University mascot, the tiger. This "feel," it is alleged, grows out of the use of the "tiger stroke." The picturesque "tiger stroke" is then unveiled as "a quick, swishing, glancing blow with the tip of the forefinger."[28] A few lines later the "tiger" blow has sadly degenerated to "just flick it lightly with the ball of the finger."[29] All that is left of the "tiger" are your fingers "curved in semicircles." Nor are sharply manicured fingernails specified.

This vivid picture of correct stroking is not inapt. Do you accept this claim that the "motion feel" in your finger is the leading factor for increasing accuracy and speed?

This successful manual reflects the crusading faith of many typewriting teachers in finger motions. Everybody agrees that finger reaches can be located fairly well by the feeling from touch, moving muscles and finger joints. Every such advantage should be seized. Everybody agrees that this keyboard location by feeling can be improved. The highlight of the matter, however, is that this slow finding of key locations is mere preliminary preparation for typewriting. This slow-finding stage is not typewriting at all. It is just what it is called — a slow finding of unfamiliar keys. "Seein' is believin'," or is it? Anybody can see a stiff finger hunt awkwardly. No one can follow complicated changes, electrical or otherwise, within the gray matter of your brain. Actual typing is a later matter of relaxed following, not of separate fingers, but of their varied *combinations* and lines.

Ask another beginning typist, and he will gratefully agree that the hunting finger "feels" awkward and stiff. Really this student is confessing that he has an unsolved problem. His solution is chiefly to discover how to control this finger by partial relaxation, and with this discovery he will relax both high finger tension and any dismayed excitement. Then any "motion feel" will also be *less*.

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[27] Wiese, E. G. and Coover, J. E., *op. cit.*

[28] *Ibid.*

[29] *Ibid.*

4. *Discarding finger "motion feel" with expert facility.* A fast typist usually is too busy to be aware of his key stroke or its "motion feel." So light and deft is the stroke, so swiftly returning almost before it is made, so relaxed away, that an honest typist could hesitate and think twice before admitting that the finger had been stroked at all. Probably the expert would have to consult his last written line. Yet once upon a time this expert must have been a beginning typist. Therefore finger motions must have been dinned in until he worked the finger muscles with might and main. How did he improve? By slowly sloughing off this excess tension and relaxing most of it away. The more he relaxed, the more his "motion feel" waxed fainter. The felt lessening of tenseness by relaxation, indeed, became an added guide to progress.

5. *Felt facility and continuity of sequences in touch typewriting.* If time is taken out to train you to detect delicate finger tensions and joint strain, you would catch not two "motion feels," but several in the lightly and swiftly shifting balances between tension and relaxation within two key strokes. Yet your observation, no matter how close, would remain greatly at fault, as a motion picture of your stroking would quickly reveal. The most critical stroking points are each finger's unnoticed and unfelt arrest as it strikes the key. Even though you cannot feel it, this should be the shortest pause which can be held and yet preserve the succession of strokes. As you gain insight into such facts, you will realize that a safer guide to successful typing lies in the felt rhythmical flow of complete lines of typing. Try the "motion feel" in emergencies to avoid taking eyes off copy.

Perhaps you already agree that as typewriting improves, patterns of your motions are felt by you as new wholes. It is the very completeness of this closer overlapping that makes an entire series of key strokes as one movement which also makes for successful typewriting. If you try to attend to some little "motion feel" in any single key stroke, you will be likely to disrupt the pace of an entire succession of strokes. To improve a stroke, you develop its overlapping with strokes before and after. Single key strokes are merged into these other strokes. A single key stroke is felt chiefly if, as a misdirected stroke or error, it temporarily blocks the rhythm and pace of the typing pattern.

6. *Pace, more than motion feel, forms movement patterns that fit balanced mathematical statements.* Perhaps you will enjoy clarifying the picture of just what is meant by motions patterned as wholes. Take paper and pencil and roughly outline a human body. Then draw in lines between toe and ankle, between ankle and knee, between points midway between ankle and knee and ankle and hip, between points midway between knee and hip and hip and shoulder. Outline this body in a different position and redraw these lines. Do you see clearly how the line angles have changed? Now if the changes in these lines are caught by a constant-speed motion-picture camera as an athlete high-dives or is cast like an aerial circus performer from one high bar to waiting hands high up on another bar, the line angles will form curves that resemble perhaps a section of an airplane wing. The pattern of such expert movements closely fits the pattern of some airplane wing.

This has been demonstrated by university mathematicians. With 3400 measurements Griffith[30] has plotted the curves of ten fluent behavior patterns, such as high diving or casting or other complete skills. Here you see complete movement systems plotted in mathematical patterns. Incidentally you discover that such plotting brings out the first difference between awkward and highly skilled movements. This difference is not in the "motion feel," but in the timing, or pace. If the athlete is frightened or awkward in his high diving or casting, the pace suffers. The popular language of athletics also refers to these smoothly timed motions as "good form."

TYPING PATTERNS AS CONTINUOUS WORD-WHOLES

1. *Fallacy of isolated letter strokes.* Many manuals suffer in common from glorifying the American letter movement. By identifying the "motion feel" with the isolated letter stroke, a needlessly incomplete picture is given to you. Moreover, the usual mistake is

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[30] Griffith, C. R., "A Graphic Study of Movement Systems," *Psychological Bulletin* (1931), Vol. XXVIII, pp. 676–677.

committed of stressing your fingers rather than your *central* control of word patterns. A letter stroke, even in terms of its "motion feel," is hardly the practical unit in typewriting. Except for the veriest beginner who has not yet mastered the simpler spatial relations of the keyboard, typewriting proceeds in unified series of strokes popularly known as *words*.

In his admirable typing studies, Coover[31] has shown that an expert typist is unable to type one-letter copy at anything like commercial speeds. One-letter copy has slowed the expert roughly to the equivalent of less than 20 words per minute. This looks ridiculously like making novices out of perfectly good experts. Two-letter copy has saved 48% of that time; three-letter copy has saved 18% of the two-letter time; and so on, improving through to seven-letter sequences.

There is something queer about an alleged unit that makes even experts look ridiculous. Far from being "the leading factor" (with or without its "motion feel"), the letter movement seems well out in front for decreasing speed. Barnhart[32] has long placed emphasis on vocabulary rather than keyboard learning. Further demolishing the letter movement, Dvorak and Ford, in their studies at the University of Washington, demonstrate that for you, as a beginner, the safer units are the most common English words typed with a felt ease.

2. *Line setting as a typing framework.* Practical typewriting patterns are the *word* and the *line*. Each is a definite pattern of successive overlapping strokes. Perhaps an unexpected fact in proofreading will help you think of the pattern of a line. As one reads from left to right across a line, his errors tend to increase. If the line pattern is divided into fourths, Crosland[33] finds that the usual increase of errors from left to right is 4%, 5%, 11%. Later you, too, will examine typing errors in their *line settings*. The carriage-return throw will also help you to think of the pattern of a line. The usual

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[31] Coover, J. E., "Principles of Learning in Typing," *Rowe Budget* (1928), Vol. XXX, p. 10.

[32] Barnhart, E. W., *Psychology of Learning Applied to Typewriting* (Gregg Publishing Company, 1922).

[33] Crosland, H. R., "An Investigation of Proofreaders' Illusions," *University of Oregon Publication* (University of Oregon, 1924), Vol. II, No. 6, pp. 77–88.

carriage return is several times slower than the usual key stroke. Incorporated in the rhythm of your typing, this is more than sufficient to add a marked accent as each line is closed.

3. *Practice words and phrases in their natural context of sentences.* When you come to think of your typing as unified wholes, whether patterned as words of familiar phrases or lines, toward what kind of copy will you direct the bulk of your practice? There is only one basic answer to this query. You will practice words in their natural context as soon as possible. Then you will feel that these words actually belong in their sentences. You will learn to type words faster as essential parts of sentences — sentences that say something! The simple fact that each sentence makes sense helps you to order the correct stroking.

Are you certain that you grasp all that it means to practice from the start on common words in complete sentences? Certainly it does not mean mastery of keyboard locations piecemeal by separate fingers, first, second, third, then fourth. Certainly it does not mean long-continued tapping of nonsense syllables on the rows, as *aoeu*, *htns* (or *asdf*, *jkl;* on the old keyboard). Nor does it even mean going gradually from such isolated and meaningless letter sequences to simple words, phrases, and finally sentences and business letters.

Virtually a decade ago Birch[34] urged for young typists graded series of simple phrases and sentences. Another dissenter, Ollie Depew,[35] said, "An unnatural combination of letters will interrupt the rhythm of even a skilled writer."

From a recent text, likewise, consider Maclean's[36] suggestion: Why make typewriting appear intricate and burden yourself with mazes of exercises comprising odd combinations of letters to boot, when typing actual sentences composed of common words is both direct and natural. It certainly is more intelligent to acquire the "motion feel" of real typing.

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[34] Birch, C. E., *The Vocabulary Method of Training Touch Typists* (Ellis Publishing Company, 1920).

[35] Depew, Ollie, *A Scientific Course in Typewriting* (Allyn and Bacon, 1921).

[36] Maclean, Lola, *Walton-Maclean Typewriting Procedure and Practice* (Walton Publishing Company, 1931), p. 3.

4. *Gilbreth motion-study notes: word sequences.* Suppose you eavesdrop for a moment on the running account of the Gilbreth motion studies of typewriting.

Speed Coach. Teaching typewriting is in its infancy. All the instruction books are simply steals from the first instruction book that was ever written. They are all wrong.

Mrs. Gilbreth. I don't doubt it. It would be for the benefit of all to have a few common things standardized. As far as I can make out, everybody is teaching it differently. In some psychology books they say that the average person thinks in letters first, then word by word, then sentence by sentence.

First Speed Typist. Word for word is about right. Sentence by sentence would be impossible.

Second Speed Typist. I find myself sometimes falling into phrases.

Speed Coach. It is against the rule to follow by phrases. Students often get themselves into trouble. When they copy by phrases, students often misstrike letters. Then they look up from their copy to the upper carriage. They lose the trend of their thought. We do not want them to get more than two words at a time. This girl might have success in copying by phrase. It depends entirely upon the mental ability of the person. I think this girl could remember accurately more words than most speed operators because she is better educated.

Mrs. Gilbreth. You mean to say that her education would act as a rectifier of what she read?

Speed Coach. Yes.

First Speed Typist. Do typists have time to stop and think?

Speed Coach. It is second nature with them to understand good English.

Mr. Gilbreth. I have some words I want you to do. *Tho, altho, thru, thruout, altho, thoroly, thorofare, program, prolog, catalog.* I want you to look at each three or four times.

First Speed Typist. This is going to be hard because it is not connected. I made a mistake in the first word.

Mr. Gilbreth. That does not matter. Type it again.

First Speed Typist. The Simplified Spelling Board in New York says that it can make me write 200 words per minute.

Mr. Gilbreth. I want the cross-sectioned screen put here. I want the lady's hands on the screen. (The screen is now 23 inches from the camera lens.)

Mr. Gilbreth. *Thoroughfare* once.

Speed Coach. She lifts her hand up at the end. That gives you a false idea. If she were to write another word, she would get ready to pounce on that letter.

* * *

(Typist with light on head and on forefinger of each hand. Cyclegraph of *thoro* with change of carriage, of *thorough* with change of carriage, of *thru* written right straight along.)

First Speed Typist. I cannot write one word over and over.

Observer. I think it is because she cannot develop a rhythm.

First Speed Typist. A business man would never ask you to write one word over and over again.

* * *

Mr. Gilbreth. I am going to let this typist give a little exhibition, and I would like her to show the co-ordination between fingers and brain. She pays no attention to her hands. Her hands have been educated to obey the impulse not in fingers, but in words and phrases.

5. *Superior improvement accompanies practice of complete typing patterns as contrasted with piecemeal material.* Happily, the facts support this direction from the outset. Perhaps you are already familiar with Pearson's [37] clear-cut demonstration that typing should be learned from the beginning as one whole of sentences and connected discourse. A dictating-machine class practicing sentences made up of the 1000 most common words was compared throughout with a similar class using a text that included nonsense-syllable drills. For the former class, typing its complete patterns, no keyboard drills were used. During the first class periods, three sentences were typed. Each day thereafter a new sentence was added while the earlier sentences slowly tapered off. On the thirteenth day, an entire paragraph of 43 common words was typed. On the twenty-first day, a letter was dictated at 10 words a minute. The first three sentences of a story then appeared, with three new sentences added daily. Business letters then became frequent. The dictating-machine method itself seems notably faster than traditional ways.

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[37] Pearson, D. C., "An Experiment with Automatization of the 1000 Commonest Words in Typewriting," Monographs in Education, First Series, No. 8, *Research Studies in Commercial Education* (University of Iowa, 1928), Vol. II, pp. 84–97.

Both classes passed the Blackstone typing test's semester norm of 88 during the ninth week! Up to this point, however, the class typing common words in sentences was superior. Its semester average was 91, that of the dictating-machine class 85, or a gain of over 5 points. Doesn't this show that so much nonsense-syllable practice is needless? Pearson hints that championship typewriting is chiefly a matter of making large numbers of words automatic.

Let Barton [38] compare for you a group of students typing piecemeal letter copy with another group who start and continue practice on complete compositions similar to what it will later use in practical work. The first learns by parts, the latter by wholes. You might refer to the one as practice by piecemeal, to the other as practice by patterns. How will the pattern group master the keyboard locations? Merely in this wise: It will spend a period making its own keyboard study and growing familiar with the modern typewriter as a machine. Will students at once try writing from copy? Hardly. They attempt something like this: "Write a letter to Jones, Smith, and Company ordering a pair of shoes which should cost $7 and should be sent by parcel post."

Once written, this letter is never "copied." Perhaps the pattern group write a letter, instead, to a friend inviting him to an evening party. These students are discovering the keyboard and its spatial relations. This early locating of reaches upon an unnecessarily difficult keyboard over a half-dozen periods is in no sense typewriting. The better learning curves of typewriting progress show nothing for this early practice. There is nothing in the way of a typing score while becoming familiar with keyboard positions. There is little, in fact, which is similar to later successful typing.

The pattern group has now written five weeks on complete compositions, including sentences and paragraphs made out of the thousand most common words. The piecemeal group has started much earlier and has now written for sixteen weeks. Before the fifteenth week it has not completed the keyboard and ninety-two exercises in a popular manual on small and meaningless material.

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[38] Barton, J. W., "Comprehensive Units in Learning Typewriting," *Psychological Monographs* (Princeton University Press, 1926), Vol. XXXV, No. 164.

Let the pattern group and the piecemeal group take the same speed tests. What happens? These tests reveal that the usual gain of the students typing piecemeal copy is 0.7 words a period, of the students typing whole patterns, 3.2 words—or 2½ more words each practice session. The proportion of errors is 11 per minute for the piecemeal group, 7 for the pattern group. The latter's average superiority, in short, is 13 words a minute after one third the practice.

This superiority, despite the lessened practice, is so outstanding that Barton repeats his experiment. This time the contrasting classes type forty periods each. What do the final scores on business letters show? These tests reveal 2.5% of errors for the piecemeal group and 1.9% of errors for the pattern group. The latter students, after 40 periods of practice on whole patterns, are more than twice as fast, roughly 20 words to 9 words per minute. They have made more than twice the daily gain.

Another typing class of 20 students has memorized the entire keyboard, then practiced sentences and later, championship-contest material. A like group during the same time has practiced the usual piecemeal manual. If you are interested in Hainfeld's[39] report, by the twelfth week this "part" group has scored 81 while the "whole" group has scored 113 on standard typing tests.

An Englishman, M. Drury Smith,[40] comes close to showing that learning by parts will help hang you in the doldrums without any progress. To focus on some piecemeal detail at the expense of other features is likely to check progress. His experiments used ring ball and a guide-it game. To play the one, you throw a rubber ball with right or left hand to a target on the wall, so that it bounces back onto a floor target. To play the other, with a knitting needle you guide a small metal ball up an inclined plane around 21 holes and wooden barriers to the top. Trouble arises if you regard the ring-ball game as made up of parts instead of as one whole task. Perhaps you focus on holding or releasing the ball, throwing more softly, or on accuracy at the cost of speed. Maybe your right throw improves while your left throw and right bounce deteriorate. Or, while you improve the latter, your right throw deteriorates. When you play the whole game from the start, you may improve steadily.

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[39] Hainfeld, C. F., "A Learning Study to Determine Whether It Is More Economical to Learn Typewriting by the 'Whole' or 'Part' Method," Master's Thesis (New York University, 1927).

[40] Smith, M. D., "Periods of Arrested Progress in the Acquisition of Skill," *British Journal of Psychology* (1930), Vol. XXI, pp. 1–27.

Of course, there is always the chance of incidental lapses in your typing due to staleness, fatigue, dismal weather, noises, poor lighting, vacation breaks, poor incentives, nervous upset, or what not. Offhand, it might seem feasible to start in semi-part fashion with single hands and pass to doublehanded typing. Yet Beeby[41] shows that in figure tracing this change always brings unexpected interference that lowers efficiency. Even in the nonserial action of sorting cards, Crafts[42] has found the whole method superior. It is better to have all the relations between the various cards and the several compartments into which you toss these cards form a complete pattern from the outset.

The effectiveness of any method is the complex result of many conditions presenting many variables.[43] Among these Grace McGeoch[44] lists the nature, the length, and the difficulty of your copy material; not only the amount but also the distribution of your practice — into shorter periods over wider intervals; the sort of part method used; varied ways of measuring your typewriting improvement and its permanence. Yet through the many experiments on whole *versus* part learning runs a consistent thread of advantage for learning *wholes*, particularly with the more capable students and after preliminary practice.[45]

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[41] Beeby, C. E., "An Experimental Investigation into the Simultaneous Constituents in an Act of Skill," *British Journal of Psychology* (1930), Vol. XX, pp. 336–353.

[42] Crafts, L. W., "Whole and Part Methods with Non-Serial Reactions," *American Journal of Psychology* (1929), Vol. XLI, pp. 543–563.

[43] See also, for a more neutral view, Lomax, B. L. "A Comparative Study of the 'Whole' and 'Part' Methods of Learning Typing in College Groups," Master's Thesis (New York University, 1929).

[44] McGeoch, G. O., "Whole-Part Problem," *Psychological Bulletin* (1931), Vol. XXVIII, pp. 731–732.

[45] See "Typing Motion Studies," Chapter X, pages 240–283.

INTERPRETATIVE SUMMARY

Whether the delicate, automatic learning known as conditioning is to be an asset or a liability rests with the stimulation utilized by the typewriting instruction. Newer directions are here taken, essential features are here sought out. In this approach, forcing an open break with older notions of isolated habits, fast typewriting is to be learned as one unified whole. Conditioning signals to compact sequences are to be made automatic by practice of movements in complete typing cycles. Learning to typewrite is building up vividly the completeness of every definite typing performance. A key to this completeness lies in the student's understanding of what the finer points of such typing are. The student typist can be well aware of each new and better pattern formed of his motions — though not of its conditioning. Such insight contributes to the conference hours in any typing class. This new focus naturally abandons isolated letter stroking and isolated drill material that is never used in practical work. Instead, the young typist, as a thinking machine, is encouraged to experiment with complete, new motions to subdue each difficulty as it is felt.

Each difficulty is a gap in the completeness of his typing. Self-experimenting should lead the student to discover a new, clear-cut, solid pattern that closes the gap. He must catch the essential point. Indeed, in an exchange of verbal suggestions between himself and the teacher or a classmate, he explains by afterthoughts how he gained this new pattern. Inferior typing, by contrast, stops far short of perfecting each pattern. The unsuccessful student's choice of a posture proves shortsighted and comfortable only for short periods. As yet, he has not discovered ballistic stroking as a clear-cut pattern. Nor is he able to select the proper words to make automatic since he is unfamiliar with scientific counts of most common words. All such patterns remain incomplete; many of the most common words are not automatized, rhythm and stroking hesitate, posture sags and invites fatigue. Even the layout of his classroom may be poorly arranged to expedite work coming to or leaving his typing table.

By successful problem solving, however, the central patterns that control typewriting are organized. By finding individual keys in their relation to the whole keyboard, the spatial keyboard pattern is organized. This is completed by fitting a student's persistent posture into a delicate balance with all keyboard reaches. Into the frameworks of language and spatial keyboard patterns, the motion patterns are thrown, supported by the fixed posture. These typing motions overlap in rhythmic succession to form compact, solid sequences — words forming useful typescript. Individual key strokes are completely merged in such patterns. Yet the isolated letter movement is still glorified in some conventional classrooms. By letter drills students can be so permanently impaired that fast, correct typing is impossible. Isolated letter stroking is shown to be not typing, but mere futile tapping. At the outset, to be sure, a pattern of finger "motion feel" is a fair stroking guide. As a beginning typist hunts a key, he can feel the tenseness of stroking finger muscles, the strain at finger joints, and touch with the finger tip. As a *ballistic* stroking pattern is caught, however, this "motion feel" is largely relaxed away. A felt rhythmic pace serves to organize these stroking patterns. Student typists should practice regular rates of typing common words in their natural framework of useful sentences, in order to promote this growing completeness.

CHAPTER VIII

MORE ABOUT COMPLETE TYPING PATTERNS

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READING SUGGESTIONS

To the Student Typist: Study the full use of your senses in getting copy and inspecting your work, beginning with the ears, pages 168 to 170, 173, and 174. Are you interested in voice writing by machine, pages 170 to 172? Study why your eyes must cling to copy, pages 174 to 178, and how to read copy, pages 178 to 182. Catch the idea of why you practice common words, pages 185 to 187. Try reading the next sections to appreciate the idea of typing patterns, pages 187 to 190, also how a definite goal and knowing the consequences of your practice help you learn, pages 190 to 193. If this is too general and difficult, however, skip to the interesting experiment with a pursuitmeter — as a miniature model of learning to typewrite, pages 193 to 197. Try to feel what is meant by insight or typing attitude, pages 198 to 200.

To the Psychology Student: The picture of Gestalt psychology to be found in typewriting is here enlarged. First, read ways in which the senses work together, particularly the ears, pages 168 to 174, and eyes, pages 174 to 183. A controversy over using eyes to learn the typewriter keyboard brings out relationships between eyes and other senses, pages 176 to 178. Use of eyes in general is explained, pages 178 to 180, and in reading, pages 180 to 183. Second, since language is the most important aspect of civilized living, the neglect of language behavior in many psychology texts is astonishing. Its pattern is briefly stated, pages 183 to 185, and a social setting added, pages 185 to 187. Third, final outcome and aftereffect form a central issue in current psychology of learning, pages 187 to 191. Here you find certain views of Thorndike adapted to the view of conditioning and its reinforcement. The principle of *effect* is identified with knowledge of results. Fourth, widespread laboratory studies using a pursuitmeter are illustrated by a clear-cut experiment, pages 193 to 195. Fifth, the emphasis on *gradients* is continued from Chapter VI, pages 196 and 197. Sixth, the chapter closes with a contrast between views of *insight* by Köhler and by Fisher or Gregg.

To the Typing Instructor: The use of all chief senses is reviewed; first, of ears, pages 168 and 169, and getting copy through direct dictation, pages

169 to 174; then of eyes, pages 174 and 175. Preliminary use of eyes to assist learning the keyboard during dictation is recommended, pages 175 to 181. Reading copy and corresponding errors are explained, pages 181 to 183. Next, a clear-cut picture is given of usage of most common words, pages 183 to 187. Then the emphasis upon fixed objectives and knowledge of results is applied to the class assignment, pages 187 to 191. Note an experiment to show the fallacy of extensive teacher talk, pages 191 to 195, qualified to include the Stuart separation of "skill" and "knowledge" learning, pages 195 and 196. Chapters VII and VIII conclude with an advanced statement of learning to typewrite as student thinking, pages 191 to 197. This stresses finding a new direction in practice, pages 196 to 198, and a successful typing attitude, pages 198 to 200. Add the interpretative summary, pages 200 and 201.

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AUDITORY PATTERNS IN TYPEWRITING

1. *Initial neglect of ear-speech patterns.* In adjusting your person to typewriting, you have plenty of chances to experiment with the feeling from motions. You are quick to find a temporary aid in the "motion feel" of key strokes. Later you appreciate feelings of desired ease in fingers as you lightly stroke keys. Inspect, say, the extent to which you now rely on "touch." Close your eyes and type in order to find any keys concerning the place of which you are still uncertain. Close your eyes and stroke the tabular key. Close your eyes and stroke the backspace key. Close your eyes and return the carriage. With much ado over the "feel" of senses from fingers as you manipulate the typewriter, insight into the supporting role of your other senses may grow one-sided. Actually your senses work together and not one is really separate. As you type, employ all the chief senses to inspect. Watch with your eyes the removal of a typed sheet while a fresh sheet is placed in your machine and centered with a straight upper edge. Do you see any idling of a left or a right hand? Inspect, too, with your eyes the lightness and evenness of imprint on the typed sheet.

Just as sight thus checks up the evenness of rhythmic typing, even so the actual stroking can be checked upon by listening to the rhythmic clicking of the keys. Listen to catch the special sounds that accompany correct stroking. Whether the stroking is labored or *ballistic* and light can be obvious to the ear, even with a "noiseless" machine. You need never mistake the sound of a heavy stroke for that of a light stroke. In the same way, listen for the sound of a correct shift, much as you may inspect with your eyes the evenness of the same capital's imprint on the paper. Listen, too, for the rhythmic sounds of a well-timed carriage throw as these sounds sink to a slight click at the end instead of a clash. Or, as paper travels into the machine, listening to the clicks may even set the distance for the top margin. Listening to the bell allows you to catch an even right margin. Listen especially for the sound changes that mark any hesitation in the regular rhythm of your typing. Perhaps you are having trouble with the reading or with some unfamiliar word. As you retype the line and listen, does this break disappear?

Listening alone will tell you a great deal, yet it is only one of your chief avenues of inspection. Moreover, you may possibly find yourself in a traditional "touch" typing class, where the customary ear-speech co-operation is lost by omitting spoken dictation. The ear seems as easy a way as any to get typing copy. At least it is a channel you have used all your life. Dictation gives you this added avenue for learning to typewrite. In practical later life, you will be likely to do much typewriting from dictation directly to yourself at the machine. You may also compose your own letters and reports and other prose on the typewriter without any reading from copy. Why not listen while much of the work in Typewriting I is dictated? Why not listen in part and also compose your own material in silent dictation to yourself? Look back upon the advantages from any personal experience with this practice, which seems rising in favor — typewriting from dictation.

2. *Gilbreth motion-study notes: dictation* versus *reading copy.* Here is another moment during the Gilbreth motion-study experiment:

Mrs. Gilbreth. We are very much interested to know whether the reaction time to an eye stimulus or an ear stimulus is quicker. Some people do faster work from copy and others do faster work from dictation.

Speed Coach. They do faster work from copying. You mean from direct dictation. I think that is a matter of knowing your dictator. How do you feel about that?

First Speed Typist. I feel I can write smoother typing from copy, probably because of lack of practice in writing from dictation.

Mrs. Gilbreth. You would think it was so, but I have heard very rapid typists say differently.

Second Speed Typist. It all depends on circumstances.

Mrs. Gilbreth. I think most people have to have a very thorough training in English. What advantage is it to be a good natural speller?

Second Speed Typist. I think it hasn't much to do with it. If you have intelligence enough to see anything and work accordingly, it is not necessary. Of course, you have to be able to spell, but you need not be an expert. When you sit down, you have the copy right in front of you.

First Speed Typist. I find when it comes to an unusual word, spelling really does help. You cannot look at a difficult word continually. I do look ahead, although this is opposed. If I did not know how to spell words, it would hinder my speed.

Second Speed Typist. When I went to school, I was taught not to look at the keyboard. The pupils would often look at the keyboard. They did not take it seriously. It was not the teacher's fault, to a certain extent, although she ought to have told them what was in it for them.

First Speed Typist. I think a great many teachers do not realize that the pupils would take more interest if the details were explained to them.

Mr. Gilbreth. The idea is this. The champion typist has got to get the copy from her eye up to the brain and then down to her fingers. We want the champion girl on the dictating machine to get the reaction from her ears to her fingers. The blind person gets information through the fingers. We are measuring all champions to see what champions are made of.

3. *Direct dictation with transcribing machines.* Fortunately, the dictating and transcribing machines are forcing all typewriting experts to concede the value of direct dictation to the typewriter. Perhaps your typing teacher has for years employed regular, direct dictation in varying amounts. Of course, a transcribing machine is easier than the direct human voice day after day. Unless you students are equipped with "noiseless" typewriters, or unless you are divided in pairs for mutual dictation, your class group must stop and

listen in order to hear what is said. Each earful must be typed before more dictation can be given. Doubtless you are familiar, however, with electrical dictating and transcribing machines and their use through tubing and earphones by small groups, each of some six typing students. With individual earphones, the awkward alternations between listening and typing disappear. Accordingly, with a dictating or transcribing machine, you could type continuously just as to any individual dictation. You would also be independent of the noise of other school machines. Since the dictation comes by ear, this would also free your eyes for other use. Usually your position would be more natural than when reading copy even with the aid of one of the better copyholders.

Voice writing has arrived out of the familiar phonograph music of the last half century. Its transcribing machine is featured by clear return of the voice through a delicate diaphragm and by electrical control. A dictating machine with its diaphragm first catches a conversational voice — punctuation marks, thoughtfully added, and all. A thousand words can be recorded on a wax cylinder. The record is then placed on a secretarial dictating or transcribing machine and used for typing. For your typing class, more permanent, louder records would be used. The earphones would be plugged in. A clearer dictating voice would be heard by using an amplifier, as in the family radio, to step up the sounds. You would be careful to cut down the "get-ready" time for adjusting headphones and yourself. The dictation would be started or repeated by your simple foot pressure, and likewise stopped by its release. Some transcribing machines add two keys attached to the typewriter frame just below the space bar which are used with the left thumb to start or stop, and with the right thumb to backspace for a rehearing. For rhythmic practice, too, you might attach a rhythm ring, or ticker, to a dictating machine. You would want, moreover, to allow for certain differences. You would want to grow familiar with the sound of a certain dictator's voice over the reproducer. You would want to listen ahead further than when reading copy. Incidentally, each cylinder's slip would also mark points at which to listen for corrections.

You may be interested in Mrs. Tedens's[1] repudiation for Chicago typing classes of the usual copybooks in exchange for this livelier direct dictation from machines. Their makers naturally do not hesitate to advertise a time saving of one school semester assured by installing earphones in these Chicago typing rooms. If you are interested in vocational typewriting, consider this voice writing. As typewriting in offices is put increasingly on a cost-accounting basis, further savings are drawn from the obvious advantage that letters written by dictating or transcribing machines are written only once. This elimination of shorthand time is reflected in such ratios as 100 dictating machine operators to 40 stenographers in one of the large insurance offices. In fact, four fifths of the firms canvassed by Nichols[2] report the use of dictating machines.

4. *Direct dictation without transcribing machines.* All this is in sharp contrast with the recent past wherein so many typing classes and instructors would have required you or any other student to copy overmuch from copybooks. Very likely your present instructor has broken to an unprecedented extent with the copybook without using dictating or transcribing machines. Combinations of noiseless typewriters, prevention of needless noise, and direct dictation make it possible to save a semester's time with or without their use. Direct dictation seems more restful than the copybook, especially if you like it. Does your instructor speak in a careful, distinct way and lend each vowel its full tone? Is this dictating voice warm in feeling and low in pitch? Of course, a high, harsh voice would be a strain even if you are accustomed to hear and carry out instructions. Direct dictation will also appeal if you spell easily. It tends to offset the help that the eyes give to spelling. In place of too much help from the copy text, you are thrown on your own responsibility for spelling.

In your earliest practice hours as a typist, the easiest way to receive copy signals is to listen while copy is dictated. A new lesson may first be explained. Then you might be asked to close your eyes and type whatever copy the teacher has dictated. The typed sheets are proofread and errors are checked. With the eyes closed, concentration upon correct stroking seems easier. At least other students seem to find it easier to learn the keyboard and to think what they are doing. Other students say that they gain confidence after typing from dictation with the eyes closed. Copy may sometimes be dictated again and typed with the eyes open. Later, the same lesson may be typed by reading from your typed copy. Is there any particular objection if you look at the keys during the early days of keyboard fumbling? This would imply that you are not establishing a habit, but are taking advantage of a visual checkup by the eyes to make definite the keyboard pattern. Even if the eyes do examine the keyboard picture, it is not necessary to watch the key for each stroke. The simple test of closing the eyes is a reassurance that you are gradually breaking away from reliance upon eyes. Closing the eyes is not only a quick test for key locations, but also for the shift key, the tabular key, the carriage return. All this implies direct dictation from your instructor or from another student.

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[1] Tedens, M. F., "Chicago Establishes Typewriting Standards," Monographs in Education, First Series, No. 11, *Research Studies in Commercial Education* (University of Iowa, 1929), Vol. IV, pp. 41–44.

[2] Nichols, F. G., "A New Conception of Office Practice," *Harvard Bulletins in Education*, No. 12 (Harvard University, 1927), p. 114 (Clerical Unit, Dictating Machine).

5. *Complete spoken words* versus *isolated-letter dictation at the outset.* Doesn't it seem as if at least a third of your introductory period should employ direct dictation to typewriters from the very start? Doesn't it seem as if direct dictation should precede writing from copy? In learning the keyboard, the advantage seems to lie with hearing the copy as a whole before there is any letter-by-letter dictation for finding motions. The advantage is shown by distinctly fewer errors. Should you be interested in a sample first dictation lesson as a new student? Suppose that your new class studies mimeographed assignments on machine operation: posture, paper insertion, carriage operation, styling or using margins and scales, tabulation, ribbon and cleaning operations, and particularly stroking. Typing motions, demonstrated by your instructor, are then imitated to the best of your ability. All felt difficulties are discussed and checked by new-type tests. In fact, you see how well you can work things out for yourself, then make out like lists of true-false, completion, matching, and problem tests and try your answers on

the machine to see if they have value. Almost from the start such sentences as this are dictated on the simplified keyboard: *She has it.* First, the sentences are dictated as wholes with capitals and punctuation explained. Then the words are dictated, perhaps being spelled out in slow rhythm as you feel for the keys with the carriage pushed out to the end, so that the machines do not print. This definitely develops the rhythm and movement patterns, rather than personal curiosity in watching what is being typed. Finally, the sentences are actually typed as the words are dictated. In this way, you are not typing to a letter dictation, but rather to complete spoken words. At once you see how well you can type a complete sequence. After two or three trials, your class stops for a rest period, for questions, and for proofreading. Nothing has been said about accuracy. Rhythm and a correct stroke are already to the fore. Soon you realize that only slow typists will persist in their beginning movements.

VISUAL PATTERNS IN TYPEWRITING

1. *Initial neglect of eye-hand patterns.* With much early ado over the "feel" of senses from your fingers, the supporting role of sight is also readily overlooked. Motions of your fingers and hands are closely linked with this glorious sense. Domination of the eyes in the eyes-fingers combination is so obvious that repeated warnings against a glance at the keyboard are given in most manuals. Where there is so much verbal smoke, there must be some fire. In countless men over slow centuries the eye and brain have combined to direct the efficient human hand, just as ear and brain have combined to control the human voice. With adults control by the eyes has long become dominant. For this reason blindfolded children are superior to adults in localizing movement by touch. In the same way, both blindfolded children and adults are superior to blind children because vision helps correct the touch of the seeing.[3] Long before the typewriting class, high school, or even college is a

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[3] Renshaw, S., Wherry, R. J., and Newlin, J. C., "Cutaneous Localization in Congenitally Blind *versus* Seeing Children and Adults," *Journal of Genetic Psychology* (1930), Vol. XXXVIII, pp. 239–247.

reality, the natural co-operation between the eye and the hand has already been so highly developed that you must battle severe resistance in overcoming this inevitable temptation to look at the keyboard. Should you discover for yourself that when the place is lost in reading copy for the sake of a tempting keyboard glance, the typing is sadly slowed and sometimes confused?

2. *Early mastery of keyboard locations by touch alone.* Recall the curiously exaggerated notions of a maze when students learned it only by "touch" in Warden's experiment. Recall also the neutral vagueness of feelings from finger tensions alone. The keyboard is a spatial pattern. Ability to handle spatial relations has little to do with mere finger dexterity. At the very start of typing, vision actually is a reliable guide and the "motion feel" a fairly clumsy one. Suppose you consider learning to trace the shortest path through an elevated finger maze. Your senses will aid you, Husband [4] finds, in this order of efficiency: first, your throat movements, guiding you with speech; second, vision, forming your visual pattern; third, a combination of language, sight, and "motion feel"; last and least, "motion feel" alone. The remarkable value of a visual checkup suggests the eyes as an aid in grasping the spatial pattern of the keyboard and in giving finer direction to key strokes.

3. *Successful, fast typing from copy by touch.* Perhaps you know typing students who have wilted under an instructor whose strict law held one look at the keyboard a high crime. To the casual onlooker such a criminal's chief offense was losing his place in the copy being read. Certainly it is more natural to have this somewhat arbitrary rule honored in the breach as well as in its observance. In case of doubt, it is safer to fall back on the correct bromide — learn typewriting or anything else *as it is to be used.* This obvious truism becomes your model. In fast typewriting it is hardly possible to permit the eyes to stray far from the reading. The successful typist must keep his eyes on the copy. If you have not yet discovered this fact, listen in for a moment upon the Gilbreth motion studies.

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[4] Husband, R. W., "Human Learning on a 4-Section, Elevated, Finger Maze," *Journal of General Psychology* (1928), Vol. I, pp. 15–28.

4. *Gilbreth motion-study notes from expert typing: eyes on copy.*

Mr. Gilbreth. Look at the copy. Look at the keys. Look at what you write. Chin up in the air. This is an attempt to get the path of the eye. (Typist changes paper and writes from copy.) There is no use in taking these pictures of him. He never shifts his eyes.

First Speed Typist. That is one of the secrets of our speed, that we never take our eyes off. We absolutely never do!

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Mr. Gilbreth. Look at copy. Look at what you have written. Look at your fingers. Now put in your paper. Now write at the bottom of the page. (Second typist changes position of copyholder, placing it nearer the machine.) As I understand it, you never look at the keys or at what you are writing?

Second Speed Typist. Yes. Occasionally I glance up near the end of the page, but the idea, of course, is no lost motion, and every look is a lost motion.

Speed Coach. That is one reason why this girl writes faster than any other typist, because she keeps her eyes on what she is writing from — more than any other operator. For forty-five minutes this typist will not backspace. That is, she writes straight along. . . . I have to be on the right side because her left ear listens for the bell. It took me a whole week to find out why she wanted me there.

Mr. Gilbreth. That is opening up a new motion economy!

Speed Coach. This typist writes from copy, and we ask the school to arrange the copy. Then I dictate a minute. Then in the last minute she writes from copy and talks to you about something else. In that case, at least, she must keep her eye on the copy. If she looks up by mistake, she stops her test.

5. *Early fumbling with keyboard locations.* Isn't this convincing enough for fast typewriting from copy? Yet what has fast typing from copy to do with any beginner who starts slowly to hunt the keyboard reaches? Typewriting practice as such does not commence until the keyboard locations are mastered and the overwhelming need to use the eyes is much less. Do you think that this is the time to challenge a beginner to keep eyes off the keyboard?

As you think over this query, notice that the traditional touch-typing class makes haste to interfere with the customary eye-hand co-operation by immediately prohibiting any help from the eyes on the keyboard. While it may seem a far cry from the typing class to the nursery, yet blindfolding the eyes and stuffing the ears with cotton have never yet been preliminaries to the baby's learning to walk. He uses his natural senses in natural sequences. Glance about the usual beginners' class struggling to locate strange keyboard reaches, if you doubt that early fumbling is excessive unless checked by sight. Not infrequently this fumbling is increased by the added distraction of having to read copy.

6. *Early mastery of keyboard locations by sight and touch during dictation.* Doubtless you will not want to turn thumbs down on visual inspection at the very start of keyboard learning, until you allow for the very suggestive gains of a class group taught typewriting from a dictating machine. A score of beginners, freed by such a machine from the burden of reading copy and correspondingly free to look at their fingers while mastering keyboard locations, wrote a third faster at the end of the semester, according to Pearson's [5] report. Their usual test scores were 42% superior to those of a class taught the usual way. Their gains were 63% greater. The usual semester Blackstone typing-test score is 88; this class's score was 136. Each student studied the locations on the keyboard and watched his finger motions. When these became definite, he was challenged to write sight unseen.

Doesn't it seem as though the arbitrary rule that dispenses with a natural visual checkup while learning keyboard locations is overrunning its usefulness? Perhaps the best approach differs for some students. Certainly no authority denies that once the reaches to keys become definite, it is vital for touch typewriting that the eyes cling to copy. You are urged to read Crooks's [6] vigorous statement in behalf of a strictly "touch" approach from the start.

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[5] Pearson, D. C., "An Experiment with the Miller Dictaphone Method of Teaching Typewriting," Monographs in Education, First Series, No. 7, *Research Studies in Commercial Education* (University of Iowa, 1926), pp. 77–87.

[6] Crooks, Maxwell, *Touch Typewriting for Teachers* (Sir Isaac Pitman and Sons, 1931), pp. 78–84.

Nevertheless, the American experiments, notably at the University of Iowa, point in the opposite direction. Instead of fumbling, there is the efficient glance of the eyes to find the center of the keys with the fingers. In less time than fumbling takes, the locations grow exact. The transition to touch will come as soon as you want to typewrite without looking. This early use of eyes to inspect implies direct dictation and riddance of distraction from early copy reading. This natural checkup ceases after you are ready to read copy and thus condition the eyes to cling to copy.

7. *Memorizing letter charts and other futile compromises.* A shoddy compromise with the visual checkup is tolerated in most typing classes. Is it required of you? This banishes the keyboard with its actual inclined plane and other spatial relations, but places a mere letter chart before the eyes of typewriting initiates. Even use of the stereopticon lantern has been urged in order to throw not only copy but also a magnified keyboard on the screen before the class. This gives a visual pattern of the letter arrangement, but not of the keyboard. It is the usual outworn stress on isolated letters. The chart tests tried out by Long[7] show little relation between knowing the keyboard by letter chart and actual stroking success. Such keyboard charts are tossed into the limbo in an Iowa class using dictating machines. Memorizing a chart seems useless to Crooks,[8] who insists that eyes always be off the keyboard. At least, there can be no uncertainty as to one item. The only place for the metal shields, aprons, and blank key caps used in so many typewriting classes the country over is the rubbish heap. The wonder grows that someone has not adapted horses' blinders for harnessing you and other typing students.

8. *Visual patterns employing the eye as a camera.* Doubtless you are more or less familiar with cameras, including your living camera, the eye. Look your neighbor in the eye and you will see the colored shutter and the aperture. Take it for granted, however, that

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[7] Long, N. C., "An Experiment with the Relative Efficiency of Various Methods of Teaching the Typewriter Keyboard," Monographs in Education, First Series, No. 11, *Research Studies in Commercial Education* (University of Iowa, 1929), Vol. IV, p. 36.

[8] Crooks, *op. cit.*, p. 48.

behind this dark pupil is a fine elastic lens focused by eye muscle, which makes the lens thicker or thinner. Eye as well as hand brings you tensions as conditioning signals, since six other eye muscles change the direction of sight. Light rays from your typing copy (or your keyboard) are reflected through this lens onto the sensitive plate — the back of your eye. The light rays register on a marvelous network of countless microscopic cones of chemicals. Here are nerve cells that step up the energy patterns from chemical changes in the cones (after the analogy of vacuum tubes stepping up long-distance telephone calls). This self-contained energy is high. Here are endings of nerve chains that connect eventually with the gray matter of your brain. Over the nerve chains these patterns may be projected in detail on gray matter along the back part of your brain. Thus a variable pattern shifts over this brain area, just as the pattern of letters plays over the banks of lamps in an electric sign. This is Lashley's [9] interesting simile. When eye muscles shift your eyes from the copy material to the keyboard, obviously a very different pattern plays over this brain area and gives you the characteristic form of the keyboard. Such a spatial pattern is supported by numerous signals from the tensions of twelve eye muscles rolling and pointing and shifting the eyeballs to scan the keyboard and to gauge acutely its reaches. You are already familiar with the slower organizing of the keyboard pattern over a related brain area by means of finger movements to touch all the keys.

Doubtless you are struck with the possibility that errors in your typing patterns may parallel errors in your visual patterns. You may know that in a few cases persons blind from birth learn to identify forms by touch. When through surgery or otherwise they acquire sight, they can describe but not identify by sight objects such as snow skis or even familiar cups or plates. They have to learn to identify by visual patterns everyday objects which they had known perfectly by touch for years. Isn't your touch typewriting just the reverse? You have now to learn to identify as stroking patterns everyday words which you had known perfectly by sight for years.

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[9] Lashley, K. S., "Basic Neural Mechanisms in Behavior," *Psychological Review* (1930), Vol. XXXVII, pp. 1–24.

The human eye sweeps along a line of copy in rapid jumps and much longer pauses. Why not type a few lines upon a card, then punch a small peephole in the card and through it watch your neighbor's slight eye jump as he reads the card.[10] Unlike typewriting, it is impossible for either of you to slow these fast eye motions. By photographing eye motions during typewriting, Butsch[11] has discovered that the eye moves only rapidly enough to supply copy to the hand as it is needed. The pauses by the eye, accordingly, increase greatly both in number and in length. Even rapid typists take in less than 4 letters on each pause, slow typists less than 3 letters. Already you read with a definite rhythm. Of course, time and rhythm are lost if the eyes must move backwards to cover words missed. The proportion of backward eye movements usually fall from 5 for slow typists to less than 2 for fast typists. As the eye approaches the end of a line, just enough is caught to carry the meaning over. Well before the end of a line the eye sweeps back to inside the next line. You may fill in partly missed line ends later with errors. In 80% of the cases fast typists appear able to carry their eye and hand motions evenly over the end of the line, but slow typists manage this in only 20% of the cases. Between other typewriting students there are the most astonishing differences in speed and rhythm of reading copy.

Fortunately, slow reading can be speeded up to match fast typing against time. If you use your eyes much as do the typists photographed, you keep an average distance ahead of the hands, so that the interval between seeing the copy and stroking the typewriter is about 1 second. Rarely is another typist more than 2.5 seconds ahead. This interval is known as the "eye-hand span." With every increase of 10 words in typing speed, this eye-hand span usually widens. Between typing speeds of 40 and 70 words, the average increase is from 3.9 to 5.9 spaces. The eyes may lag as far back as the letter being stroked, or may be more than 10 paces ahead. Infrequently a familiar phrase may permit your eyes to jump far ahead. Thus, another typist has stroked *m* as his eye read *he* in the phrase "him, just as if he." This would give the typing eye-hand span a range from 0 to 13 spaces. In general, notice that ordinary typists read one word ahead of the typing and rapid typists read one and one half words ahead. During more than half the typing even the most rapid operators are not reading two words ahead.

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[10] Miles, W. R. and Segel, David, "Clinical Observation of Eye Movements in the Rating of Reading Ability," *Journal of Educational Psychology* (1929), Vol. XX, pp. 520–529.

[11] Butsch, R. L. C., "Eye Movements and the Eye-Hand Span in Typewriting," *Journal of Educational Psychology* (1932), Vol. XXIII, pp. 104–121.

9. *Reading copy in word-wholes.* Like typewriting, reading moves in word-wholes. Try reading by letters and your speed will be cut in half. Any beginning typist, to be sure, may pronounce every sound softly as he strikes the corresponding letter key with a slow, careful stroke. Yet you notice that this is no more reading than it is typewriting. Such practice is preliminary exploring of a keyboard. It could not be typewriting. Not even proofreading is letter by letter. Well-known groups of numbers, too, are read as wholes.

It is true that certain determining letters contribute essential signals for your conditioning, especially the first letter and any consonants rising above the main line of print. Thus the tall *l* is effective, as are *y* with its curved tail and *i* with its dot. A few such signs from the first half of the word and the upper halves of the letters should be sufficient signals for *you* to form the word. A word is caught from such cues in its familiar outline, and you fill in with your personal visual or speech patterns. In fact, word outlines can be read at a distance too great (or in type too small) to see the letters.

There is no relation between the poor legibility of a letter such as *a* or *n* and its letter-stroke skill on the typewriter. This is obvious at a glance if you compare legibility with the proportion of letter errors in typewriting. (See Table VII, page 182.)

As soon as you deal in words rather than mere letters, the parallel with typing errors commences. The hard spot is at the center of a word or immediately at the right of the center.[12] As the eye centers

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[12] Mendenhall, J. E., "The Characteristics of Spelling Errors," *Journal of Educational Psychology* (1930), Vol. XXI, p. 655.

TABLE VII

Rank of Letters in Legibility Compared with Rank of Letter Strokes in Skill (From Crosland[13])

Letter and Stroke	y	i	j	d	l	e	f	u	g	t	w	o	m	s	r	h	k	x	b	c	z	p	a	v	q	n
Legibility	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Skill	8	11	24	18	7	5	20	14	19	6	17	4	15	10	12	3	23	22	16	13	26	2	1	21	25	9

on the word, you are liable to fill in the latter part of the word yourself. Reading errors appear to increase from left to right, that is, from the first to the sixth letter position.[14] This seems true in typewriting. Unfamiliar matter, too, increases reading errors. Be sure to read even such copy for the meaning. If you understand what you are reading, the right words all seem to belong together. Otherwise, something in you may lead you to read a word error as you type it — as a word which you incorrectly substitute or add or type in the wrong place. No amount of experience can eliminate your background or prevent its inclusion in your reading. If you become absorbed, likewise, in highly interesting copy, you may speed up reading, with resulting errors in both fields.

10. *Completing visual patterns by inner speech.* From the fragmentary visual signals already mentioned, the forms of words are filled in by your own speech patterns — minute movements of your speech muscles as you silently pronounce the words — or by your own visual patterns. Just as your silent inner speech may lag

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[13] Crosland, H. R. and Johnson, G., "The Range of Apprehension as Affected by Interletter Hair-Spacing and by the Characteristics of Individual Letters," *Journal of Applied Psychology* (1928), Vol. XII, p. 104.

[14] Crosland, H. R., "Letter-Position Effects in the Range of Attention Experiment, as Affected by the Number of Letters in Each Exposure," *Journal of Experimental Psychology* (1931), Vol. XIV, p. 504.

several words behind your eyes, so your typewriting may lag a word or more behind this inner speech. Three unified patterns of sight, of silent speech, and of typing motions thus control as one the transfer of copy to the typewritten page.

SPEECH PATTERNS IN TYPEWRITING

You have just been reading for several pages a clear summary from Crosland[15] of the use of the eyes in reading copy. If the forms of words are filled in by your silent speech, to think a moment of talk as talk might be a clever aid to typing insight. Possibly everyday conversation can illumine typing patterns, which you recall follow the words of connected written English.

Consider for a moment telephone conversations. French[16] gives you a list of some 80,000 words used in 500 telephone conversations, mostly business calls between men. (See Table VIII, page 184.) A very striking result at once emerges. The essential feature of your typewriting is revealed more vividly than in any word counts of written copy. How? Telephone conversations between business men are based on a framework built up of a relatively small number of words, arranged in many patterns. For that matter, less than 3% in some 80,000 are different words. But the little auxiliary verbs, such as *is*, and pronouns, such as *you* and *I*, and prepositions, such as *on* or *to*, and conjunctions, such as *and*, and articles, like *the*, constitute only 5% of the different words used. Mostly the words are monosyllables. Yet they make up 57% of all these 500 telephone conversations. To omit them would change materially the occurrence of sounds. This framework supports the longer, more varied, less frequent words, which convey most of the meaning. To omit the least frequent two thirds of all words would have a negligible effect on your typing sequences. The everyday monosyllables materially set the letter combinations that you must type.

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[15] Crosland, H. R., "An Investigation of Proofreaders' Illusions," *University of Oregon Publication* (University of Oregon, 1924), Vol. II, No. 6, pp. 139–163.

[16] French, N. R., Carter, Jr., C. W., and Koenig, Jr., W., "The Words and Sounds of Telephone Conversation," *Bell System Technical Journal* (1930), Vol. IX, pp. 290–324.

TABLE VIII

AVERAGE NUMBER OF REPETITIONS OF WORDS, CLASSIFIED BY PARTS OF SPEECH, IN 500 TELEPHONE CONVERSATIONS (From French *et al.*[17])

Parts of Speech	Articles	Prepositions; Conjunctions	Pronouns	Auxiliary Verbs	Verbs	Adjectives; Adverbs	Nouns
Repetitions .	1850	344	398	255	27	15	11
Number of Words . .	3	36	45	37	456	634	1029

Suppose this seven hours of telephone conversing, that repeats only 2240 different words in a total of some 80,000, should go on for a week. In proportion, perhaps 5000 words would be repeated and repeated to form 2,000,000. Hence of the first 200 nouns used, perhaps one half would be different; of the first 1000 nouns used, perhaps one third would be different; of 11,660 nouns used, perhaps one tenth would be different.[18] In the same way, fewer and fewer new verbs would be encountered. In the same way, as your typewriting progresses, fewer and fewer new words are encountered.

This likeness between the word lists for conversation and for written English persists despite differences. Written matter is more formal. You qualify it by dependent clauses and phrases, with more synonyms and ampler vocabulary, but with fewer framework words such as auxiliary verbs (like *can*) and pronouns (like *him, them*). In these telephone conversations, 155 words represent four fifths of all those used; whereas, according to Dewey,[19] 640 words represent four fifths of written English. In these telephone conversations, 30 words represent one half of all those used; whereas 69 words represent one half of written English.[20] Yet the likeness persists. *Typing patterns are based on a framework built up of a*

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[17] French, N. R., Carter, Jr., C. W., and Koenig, Jr., W., "The Words and Sounds of Telephone Conversation," *Bell System Technical Journal* (1930), Vol. IX, pp. 290–324.

[18] *Ibid.*

[19] Dewey, G., "Relative Frequency of English Speech Sounds," *Harvard Studies in Education* (Harvard University Press, 1923), Vol. IV.

[20] *Ibid.*

TABLE IX

THE 50 MOST COMMON WORDS IN 500 TELEPHONE CONVERSATIONS AND TOTAL NUMBER OF TIMES WORD WAS USED, WITH WORDS LESS COMMON IN WRITTEN ENGLISH IN ITALICS (From French *et al.*[21])

Frequency	Word	Frequency	Word	Frequency	Word
3990	I	887	*see*	458	*day*
3540	you	883	have	418	*thing*
3110	the	823	for	410	*say*
2060	a	753	*know*	396	*can*
2046	on	640	*don't*	386	*call*
1942	to	638	*do*	379	would
1792	that	618	are	370	*them*
1605	it	599	*want*	358	was
1506	is	597	*go*	339	*now*
1363	and	553	*tell*	338	from
1360	*get*	518	with	336	what
1305	will	496	me	330	*morning*
1190	of	486	*him*	326	an
1170	in	480	*about*	321	*just*
1115	he	476	at	317	*over*
1100	we	474	*think*	296	be
913	they	473	this		

relatively small number of words, arranged in many patterns. This framework supports the longer, more varied, less frequent words. Into this framework, into its patterns, you fit your flying fingers.

SOCIAL PATTERNS IN TYPING SITUATIONS

Suppose you change rapidly. Suppose you build these various typing patterns into yourself. Your stroking skill becomes sensitive to slight changes in copy signals and instantly responsive in available typing motions. Now Bruce[22] asks you to give up the notion that such skill belongs so exclusively to yourself. Your "habits" are not just you. If produced in certain social surroundings, "habit" has to be maintained in certain social surroundings. If typewriting conditions change, the "habit" will change. Handwriting habits, to use Bruce's illustration, if learned on well-made desks under an instructor holding down the speed, will be greatly altered if these conditions change — if you must now write with a pad held in the hand in a very real hurry. Thus changes in only two of many conditions — equipment and speed required — quite alter the habit. Your "habit" does not maintain itself. If typewriting habits persist, it is because the equipment you are using remains similar, the social influences of your class and instructor and other typing associates remain similar. Let your own energy overflow in these common social patterns invented and promoted by other persons. It is the situation as a whole, including yourself and other people in it, that maintains the "habit."

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[21] French, N. R., Carter, Jr., C. W., and Koenig, Jr., W., *op. cit.*

[22] Bruce, W. F., "Shall 'Habits' Be Discarded in Educational Psychology?" *Journal of Educational Psychology* (1930), Vol. XXI, pp. 479–488.

Is your head already ringing with this lengthy parade of patterns? It is true that English is notoriously inconsistent and stupid in its spelling patterns, as in *elephant, eight, laugh.* Yet here are *patterns of your copy.* The printed sentences are patterned after running conversation. As your eyes jump along the line, you are reading these patterns of words and phrases. Here are *visual patterns.* Here, too, you may fill in with *patterns of your inner speech.* It is true that the "universal" keyboard, which like Topsy "just growed," often forces awkward motion patterns, often shifts an excessive burden upon certain fingers. Yet already you have projected this *keyboard pattern* upon the gray matter of your plastic brain. It is true that the *motion patterns* delivered by your own delicately balanced eye-brain-speech-fingers machine are not infrequently at fault. In any event, improvement is sustained by *emotional patterns,* popularly known as your interest. It is true that the *social pattern* (of other persons present) may prove useless or even harmful — your co-operating instructor, classmates, and manual, and later your employer or office supervisor may fail you at critical points. Far more often their mutual aid upholds your better typing. In fact, it is easier to improve such patterns, forming out of your previous practice, than to work upon hundreds of little detailed habits, pictured in some other views of psychology. It is remarkable how all these patterns, you and your typing motions included, can be fortunately fused into one *Typing Pattern.* Correct changes in this total pattern are also improvements in your typing. By motion studies, co-operative on a large scale, the Gilbreths would transform this total pattern into the "one best way."

FINAL OUTCOME AND AFTEREFFECTS

1. *Flexible motions, but fixed outcomes.* Do you wonder about all these changes in your varied copy and ways of getting copy, in your improved self and easier typing motions, in the useful pressure from your social typing group? If new typing "habits" stay sensitive and so instantly responsive to such slight changes, how are you ever to pin them down? How can you hold such "habits" that differ over a wide range from day to day? The remarkable fact is that each flexible typing "habit" does remain stable in the sense that you may employ it tomorrow and a year hence.

This high light of typing skill is finely etched by Bruce.[23] Each typing pattern persists toward a result that is desired. It is not the successive motions that must be fixed and similar. It is the desired *outcome* that you must find and hold fixed. The manipulating of a typewriter varies, yet the result is quite the same. Morgan[24] has named this "persistency with varied effort." Each "habit" that has taken form during previous typing persists despite its variety of flexible motions adapted to new copy and new machines and new surroundings. Indeed, changeable conditions require changeable motions. Just as handwriting "habits" persist toward a desired legibility, so these changeable typing patterns persist into the fast, accurate typing output required.[25]

2. *Consequences that fit the pattern of your assignment and prior experience.* For you to discuss the consequences of your typing studies and ignore the stress placed by Thorndike upon such aftereffects would be a curious procedure. It would be as queer, relatively, as for an ill man to reject the services of the Mayo Clinic, or for a criminal to reject a defense by Clarence Darrow. Although skeptical

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[23] Bruce, W. F., "Shall 'Habit' Be Discarded in Educational Psychology?" *Journal of Educational Psychology* (1930), Vol. XXI, pp. 479–488.

[24] *Ibid.*

[25] *Ibid.*

of "conditioning," this famous psychologist has more than emphasized the consequences of practice. For illustration, Thorndike[26] has asked his students to choose one of five meanings of words. Although each student would have five possible answers, the consequences of the answer would vary. With one answer, he would hear the satisfying word "Right"; with another, he would hear the annoying word "Wrong." The answer rewarded by the word "Right" has persisted. The answer followed by the word "Wrong" has not. The "Wrong" answers, even when more frequently repeated, have shortly been displaced by the rewarded "Right" answers. To know that your assigned typing is correctly worked virtually clinches your improvement. Why else do you build up progress charts and forever check and double-check your work, if not to develop your typing rapidly toward the desired outcome?

It may be that this need to know your results also helps to a clearer picture of reinforcement for usable typewriting signals. In the reinforcement of your typing you play the chief role, not your instructor, or your manual, or your class. All your life you have been building up your own special ways of acting. All your life you have been slowly conditioned to avoid certain cues and approach others. Probably you have learned to avoid fully as much as you accept.[27] You have grown up in a social world. Accordingly, you are fairly conditioned to avoid roles that bring annoying social consequences.[28] That is why the typing class is a social group wherein the "trouble" roles are promptly frowned on.

Suppose that all your life, however, you have relied on rather wasteful, poorly co-ordinated motions. Suppose you are already conditioned to avoid the kind of work stressed in your typing class. Then your past will intrude in the guise of interference. It will be extremely difficult for you to complete assigned typing. In other words, it will be extremely difficult for you to hit on a successful supply of motions. Your practice may disrupt your typewriting, not improve it. Almost as your tailor must carefully fit his chalked pattern of your new suit to you, if an analogy can be so crudely drawn, so the pattern of each typing task must somehow fit you, your previous practice, your prior experience. Any new manipulating of the typewriter must somehow fit into whatever pattern is set up in you by the new lesson, previous typing practice, and other prior experience.[29] If your set or attitude is poor, only poor motions can fit. Otherwise you may be successful. As Hunter[30] might say, your new motions *and your old* both together dominate you.

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[26] Thorndike, E. L., *Human Learning* (D. Appleton-Century Company, Inc., 1931).

[27] Cason, Hulsey, "The Learning and Retention of Pleasant and Unpleasant Activities," *Archives of Psychology*, No. 134 (Columbia University, 1932).

[28] See Filter, R. O. and Held, O. C., *The Growth of Ability* (Warwick and York, 1930), pp. 99–100.

If you already have a fairly respectable ability with the typewriter, then poorly co-ordinated motions no longer fit and automatically disappear. A new typing motion must first be accepted by you as "belonging," to use a term from Thorndike.[31] At that moment it "belongs" to whatever you are and want to be as a typist. In you this new motion is now well co-ordinated and reinforced and automatically persists. Workable signals sooner or later are attached to a supply of new and old typing motions which fit yourself and your particular job. The job itself is at last finished. Your knowledge of this result is a sign of its completeness. Your muscular tensions are at once released, as you already know, in relaxation that is always pleasant. The rewards of this daily typing success are cumulative. The new motions now belong to you, hence you are changed. To try you with very simple examples, observe the aftereffect of knowledge of results by young children. When small youngsters throw rings over a post, the effect of successful ringing is to increase the overthrows.[32] When throwing at a target, the efficiency of throws close to each hit is higher.[33] For tomorrow's typewriting practice today's success has already become part of your prior experience. In such complicated skills as typewriting, McGeoch[34] suggests there may be still wider, as yet unknown effects as you and the elaborate systems of your finger movements together change toward skilled operation.

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[29] *Ibid.*

[30] Murchison, Carl, Editor, *The Foundations of Experimental Psychology*, "Experimental Studies of Learning" by W. S. Hunter (Clark University Press, 1929), p. 622.

[31] *Op. cit.*

[32] Goodenough, F. L. and Brian, C. R., "Certain Factors Underlying the Acquisition of Motor Skill by Pre-School Children," *Journal of Experimental Psychology* (1929), Vol. XII, pp. 127–155.

[33] Hicks, J. A., "The Acquisition of Motor Skill in Young Children," *Child Development* (1930), Vol. I, pp. 90–105.

3. *Pattern of the typing assignment.* How is the day's stint of typing to fit into the whole course of your practice, or over a term at least? How can a field of typing be charted for you? Your teacher and the experts who prepare your manuals are already adjusted to the Skilled Typing Field. They seek to create in you a similar field, so that a similar system of typing motions will be performed by you. Changes most needed in you are carefully outlined and probably related to other commercial courses. Their high points are to be intensified until these dominate your typing behavior. Each important difficulty is carefully spaced, period by period, so that tensions arising from each new problem are shortly relaxed with success. The result is your steady, persistent change made possible by detailed instruction sheets and practice exercises. New tasks, as remedies, grow from your instructor's check of incomplete work.[35] Why not call these detailed study plans the *pattern of your assignment?*[36]

To reduce each assignment, you draw upon available motions as your "tools." Already you are calling such manipulation of a typewriter your *pattern of movements.*[37] Virtually, you match these two patterns. Whether your use of such "tools" is clumsy or clever depends on yourself; for your own central control launches in muscles and senses the energy, speed, and accuracy known as *typing efficiency.*[38]

It is a relief to discover how flexible is this scheme, if upheld by varied incentives, as pictured in Chapter III.[39] Every student in your typing group feels different incentives and the dominance of his conditioning signals differs accordingly. His personal conditioning may lead each student to complete the assignment in a different way. Each new service of unfamiliar copy starts a fresh problem to be handled in these quite personal ways. Yet the class assignment controls throughout. It alone can be the final outcome of the practice. This desirable result is secured by your inspection of your results and by the instructor's final check. If you are a superior student, very likely you surpass the required minimum. You are able to complete all three *levels* of work usually assigned to fit the slow, the usual, and the fast student typists. In every case an assignment, correctly given and checked, brings you full knowledge of your results.

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[34] McGeoch, J. A., "Review of E. L. Thorndike's *Human Learning,*" *Psychological Bulletin* (1931), Vol. XXVIII, pp. 467–477.

[35] See Maguire, E. R., *The Group-Study Plan* (Charles Scribner's Sons, 1928).

[36] Muenzinger, K. F., "The Primary Factors in Learning," *Psychological Review* (1931), Vol. XXXVIII, pp. 347–358.

[37] *Ibid.*

[38] *Ibid.*

[39] See pp. 46–69.

DIRECTION OF TYPING PRACTICE

1. *Attacking typing difficulties by trial and system.* When you shop, you deal in dollars and cents. When you type, you deal in net words per minute; this is the currency of your practice. The daily practice is set to reach the standard speed and accuracy scores, in the direction of a fixed outcome (such as 50 net words per minute). Yet it may not be realized just how new this direction is for you. It may not be realized that you must work out the details of this direction as you go along. As a chieftain of your own typing studies, parade your resources in review before you start. If you should pass in review all your "habits" by starting first with little, narrow, fixed habits, then the habits more flexible, then a little more and still more, until you finally reach the acme of flexibility, are you still parading habits? Yes and no; for the acme of flexibility is successful thinking.[40]

Any instructor who hurries you into mere routine, in his confusion has lost sight of your direction — towards more correct and faster motions. Occasionally a typing instructor reflects the slang phrase, "I don't know where I'm going, but I'm on my way." Ask yourself this simple question, "How is my direction controlled, by routine finger drills or by myself?" Your answer returns you to Chapter IV after a self-propelled voyage to psychological regions where "conditioning" signals control complete situations as "patterned" wholes. Your instructor can only point out some high lights which seem likely to help you discover each knack of typewriting. The typing-class situation is prepared, and you must make each leap yourself. If your finger lands awkwardly, try again in a slightly different way. You must mix trials and guesses with deliberate selection of the best, in order to learn by "trial and system."[41] Learning to typewrite is just such problem solving. Yet you travel a variable route to your goal.[42] You may solve the difficulties in certain ways; your equally successful chum may solve them in other ways. In actual practice each new motion is given its real test. In the first place, as Ogden[43] urges, it must suit your feeling of its fitness. In the second place, it must bring results.

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[40] Bruce, W. F., "Habits, Intelligence, and Analysis," *Journal of Educational Psychology* (1930), Vol. XXI, pp. 574-585.

2. *Applying information and materials in a new direction.* As you work with a typewriter, it is always important to see clearly the direction of the next changes within your present typewriting field. Illustrations may be drawn from another field. If you are familiar with Judd's[44] experiment on verbal direction, you may recall that two groups of boys have been shooting with a dart at a target under water. Only the first group has been told of light refraction and how the target looks deflected in water. With the target 12 inches under water, little difference has appeared in the shooting. With the target raised to only 4 inches under water, however, the directed boys have successfully changed their aim, while the undirected boys have grown confused. Suppose yourself, again, as a student in a physics laboratory urged to solve this problem: Construct two special pendulums.[45] All the information and material necessary to invent these two special pendulums are then given you in three separate parts. Probably you will fail to invent your pendulums. Probably you will try to solve your problem wrongly in ways to which you are

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[41] Thorndike, *op. cit.*

[42] *Ibid.*

[43] Ogden, R. M., *Psychology and Education* (Harcourt, Brace and Company, 1926), pp. 130–146.

[44] Judd, C. H., "The Relation of Special Training to General Intelligence," *Educational Review* (1908), Vol. XXXVI, pp. 28–42.

[45] Maier, N. R. F., "Reasoning in Humans. I. On Direction," *Journal of Comparative Psychology* (1930), Vol. X, pp. 115–143.

accustomed. You will misinterpret the help furnished in three lessons by the instructor because you are still thinking in terms of your own old experience. What you want to do is to hit on possibilities new to you. What you want is to see the problem in a certain new light, to attack it in a new way, that is, in a new direction. Attacked in this new direction the three sets of information from your instructor become usable.[46]

The directions of your typing practice are cumulative. While you are dependent on your own trials and errors, an unsystematic direction may be changed by telling your troubles aloud while your instructor listens, perhaps hints. Perhaps in your next attempt with the typewriter you suddenly find a new focus for your typing practice. You thus break out of a rut of your own making.

3. *Fallacy of extensive instructor talk and full-spoken directions.* An improved direction can be felt and yet not told in words. After all, you are improving a supply of typing motions, not of speech movements in your throat. You will be interested in an experiment that shows this clearly. Have you ever used a pursuitmeter? It can give you a strenuous three minutes! First, you sit before a little table and an upright screen. Out through the screen extends an iron arm. It bears on its top an upright one-inch piece of tubing called the "bead." The top of this bead is slightly rounded with a tiny electrode in its center. Really this bead is driven by hidden gears and will keep moving with different speeds and directions too involved to put in words. All you have to do is keep holding a little hammer right on this tricky bead. If you fail, the hammer slips, the electric contact is broken, and a buzzer sounds your failure.

Almost without exception, as with typewriting, most students begin with self-imposed silent directions to themselves that are as utterly unlike the best way as you can conceive. As this tricky little bead starts to run, the natural attack is to go after it actively and tensely. Soon you discover that it is harder than it looks. You try to anticipate its next move. Where in the world is it going next? Of course, you guess wrongly and hear the fatal buzzer. Your tension rises, your performance grows worse and worse. Or you start to hold the hammer near its head, so that the contact easily breaks. Or you grip the hammer tightly, and blunt the fine feeling in hand and fingers that is a better guide here than your eyesight. The harder the grip, the more tired and unsteady you grow. Really there is only one best way to keep the little hammer on the bead. It is to reverse all this and become a sort of relaxed follower of the moving bead.

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[46] *Ibid.*

Renshaw and Postle[47] have divided their pursuitmeter students into three sections. To the third section have been given most careful spoken directions on just what to do and what not to do. They have been warned against all the above. Each day they have been told in detail every difficulty and the best way to get around each. It has been such "good" teaching that they have soon learned to tell another person exactly what to do to follow the bead! As far as following with speech movements goes, they have learned their pursuitmeter. There has been, in contrast, no teacher talk for the first and second sections. The latter have merely been urged to use all their cleverness to think out the best ways to keep going. They have heard, "Try to figure out for yourself the system that will get the best results. Try to remember the things you do that improve your method." And the first section? They have just been told to keep the hammer running with the bead. Very likely they have had to add considerable thinking on their own accord.

What has happened with these three sections: (1) Uninstructed, (2) Problem Solving, (3) Fully Instructed?

To hear all the instructor's directions and learn first how to tell all about following the pursuitmeter has been actually detrimental. This fully instructed group has made strikingly little improvement. In fact, the students have been at a loss until they have dropped so much silently spoken direction to themselves and have just followed the bead with the hand. By the fifth day, this fully instructed group still is making 132 breaks; the self-directed and thinking groups, only 40 and 41 breaks. It seems that any typing instructor who bubbles over with vocal instructions in any typewriter workroom should first try the pursuitmeter. Telling and doing are not one. You, as the student, play the chief role.

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[47] Renshaw, S. and Postle, D. K., "Pursuit Learning under Three Types of Instructions," *Journal of General Psychology* (1928), Vol. I, pp. 360–367.

4. *Limited control by self-told silent directions.* The pursuitmeter has given you a pretty convincing demonstration that the best direction is controlled only in part by conversation. Yet you certainly will not jump to the notion that self-spoken thought directions are of no help in typewriting. Different, more complicated skills are employed in your typing. For one thing, in typing you set your own pace and pattern. Renshaw and Postle [48] are first in advising that spoken directions would be useful to change the actual direction or the timing of typing motions, or in counting. Your typing motions can be represented as "left" and "right," as called-for reaches or other motions, as serial order of stroking certain words or line sequences. Language remains useful in such representing, but it is never a full substitute for the actual motions. Its spoken throat movements are a complement to typing motions. Moreover, silent speech is to be dropped the moment it outlives its need.

Lest these thought directions be prematurely dropped, however, or even overlooked, Stuart [49] goes so far as to separate "knowledge" learning from "skill" learning. This is an important distinction. Its formal use is easily abused. Before you and other student typists attempt correct performance at the machine, you are acquainted with the facts needed in understanding this particular performance. Often a demonstration on your teacher's machine is enough. Any verbal preparation is readily carried too far. Just what facts, for instance, should be given you as a student? What use will you promptly make of them? Are you to read and hear just enough to help set a stage for your actual tryout of the new lesson? Are you to hear just enough to set your muscles for a more clever attack on this new lesson? If so, well and good. It is quite another matter if you are to discuss a new typing operation in detail before you try it. Conference discussions are fruitless affairs unless you and your classmates have something to contribute from actual experience. Such premature conferences, with their spoonfed directions, are as detrimental to relaxed following of copy with a typewriter as they are to following a bead with a pursuitmeter. Such prior knowledge is wasteful, just as memorizing a keyboard chart before you actually start to stroke the keyboard is a fruitless effort. Conversation about new motions is made up of afterthoughts. These appear after you have caught the motion. Such afterthoughts are neatly checked by new-type tests. In these tests "skill" and "knowledge" learning are aptly separated. It seems safer to offset this moderate separation, which can easily be carried too far, by the SoRelle and Smith [50] stress upon "technique first."

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[48] *Ibid.*

[49] Stuart, E. R., *Stuart Typing* (D. C. Heath and Company, 1932), p. ii.

5. *Direction as a typewriting gradient.* Notice, finally, that the direction you follow to typewriting skill has already been described as a *gradient.*[51] This is merely the slope of your activity from the necessary practice to the final desired result. It is the line of *least possible action* for you to follow in order to become a skillful typist.

If you are a college student studying living creatures in a biology laboratory, it is simple to demonstrate gradients.[52] Thus, as you watch a little creature of only one cell (like an amoeba) under the microscope, it might hit against a food particle. Its activity at the point touching food is increased. At this point the little creature starts to flow around the food particle and thus absorb it. The parts of the little creature further away from this point are less and less active. The downslope of activity from this point is a gradient. Isn't that simple enough? Doesn't it control the amoeba's reaction? It should also be said that you [53] and other typists have developed a marvelous nervous system to step up similar gradients, or changing activity, in every sequence which you type. Try swiftly to typewrite one of the typing "demons," a word such as *effort,* on the "universal" keyboard. Do you not feel the rising energy it takes to catch that final "*t*"? Try the gradations in *Mississippi* forced by the double tapping. Your improvement in typing these and other words is not a simple matter of striking correct letters, but rather of maintaining least possible tensions within the sequence as a whole. As you improve the blow and relaxed rebound of your stroking, gradients can be felt in your rhythm. You will find gradients in familiar and unfamiliar phrases, indeed, in entire lines. These line gradients will develop under fire, so to speak, as your fingers with all possible fluency seek the rhythmic strokes of an entire line. On a still wider scale, each typing assignment can be felt as a rising and falling activity until all copy is typed and the muscles finally relax.

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[50] SoRelle, R. P. and Smith, H. H., *Gregg Typing Techniques and Projects* (Gregg Publishing Company, 1931), p. ii.

[51] See pp. 107–111.

[52] See Herrick, C. J., *Neurological Foundations of Animal Behavior* (Henry Holt and Company, 1924).

[53] See Raup, R. B., *Complacency* (The Macmillan Company, 1926).

The direction you are now asked to consider, however, is the total line of your progress. Call it a "gradient" if you grasp the word. Call it your line or path to success, if you prefer. This line, from your earliest practice to your final graduation as a typist, is an "invisible" slope. If the notion of an invisible slope baffles you, notice the general direction of learning curves charted by other typing students.[54] An invisible slope can actually be drawn into the diagram by a dotted line. It is an invisible slope or gradient that actually shapes your progress. In order to uncover facts about learning, psychologists have studied again and again hungry white rats learning to run the shortest path through a maze of runways, blind alleys, and detours to a feedbox. Why does each white rat choose the shorter, more direct path more rapidly as he nears his goal? He is following whatever gradient brings him in the shortest, most direct line to food and relief for his hunger. Hull [55] tells you that many facts already known about learning fit a gradient that controls from the start of the maze throughout to the feedbox at the end. If you are a beginner at typewriting, you may have spent a good deal of energy to hold your original direction. To what end is all this energy if its direction has been poorly taken? To focus practice with a new direction is the first sign of learning and more important than to dillydally unduly over errors. The errors will usually disappear if your direction and its concrete goal are correct.

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[54] See Progress Chart, Figure 22, p. 434.

[55] Hull, C. L., "The Goal Gradient Hypothesis and Maze Learning," *Psychological Review* (1932), Vol. XXXIX, pp. 25–43.

MORE ABOUT INSIGHT

1. *Köhler's picture of insight.* As you hit on better motions in longer sequences, Köhler[56] would call this *organizing* the typing field into new wholes. The felt "whys" and "hows" of this organizing he would call *insight.* In fact, Fisher[57] says such insight is chiefly afterthoughts to explain how you gained the new pattern. When you try to explain how you improved and why, these afterthoughts occur. You size it all up in silent or spoken speech. This implies that much typing progress happens without insight.

A typewriting lesson might be described by Köhler[58] in somewhat this fashion:

The instructor tries to explain to you a fairly difficult operation in typewriting. He demonstrates with the utmost care and with all possible clearness. He does not have much success at first. Something remains dull in the faces of you students. So the instructor repeats. Perhaps in the course of the third repetition one face here, another there, will suddenly undergo a marked change toward "brightness." Soon afterwards he may call upon the owner of one of those changed faces to demonstrate the new step in typewriting.

You are the student called upon, and you are able to do what is asked. Something important enough to be immediately visible in your face and to make this new performance possible has happened. Your thinking, however, has not been easy. At first you have followed this part, then that part of the instructor's demonstration. At first you have failed to see any relations between his separate points. For a while you have failed to see that each feature emphasized is essential to the whole. Always you, as a student, must furnish something from your side. This may be called *understanding* of the whole. Even though you see its chief features presented piece by piece, you must first transform them into a whole. Until you succeed there is a gap, unfinished, open, missing, and you feel unrest. By finding the missing relations you achieve a balanced pattern. You organize that particular typing problem. You are likewise able to size up your solution in spoken words.

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[56] Köhler, Wolfgang, in *Psychologies of 1930,* Carl Murchison, Editor (Clark University Press, 1930).

[57] Fisher, S. C., "A Critique of Insight in Köhler's Gestalt Psychology," *American Journal of Psychology* (1931), Vol. XLIII, pp. 131–136.

[58] *Ibid.*

2. *Individual changes in expert typing.* When your faster typing commences to flow forward along lines of unfamiliar copy, increasingly it becomes individual in the sense that your motions and their sequences change as they occur.[59] They change to meet the peculiarities of fresh copy or of any new situation in which you happen to find yourself with a typewriter. Such copy is typed in ways that form your own personal style of typing.

An expert's typing is individual to a greater degree. Yet an expert typist simply follows gradients that carry him along with the least possible action. His typing flows forward with automatic ease. Let an expert tell how he "organizes" each line, although you realize that ordinarily he is quite unaware of such ways and means. He feels successively, so he says, just the right balances of necessary tension close the gap between the new copy and the typing. For each change of place and copy, so he says, he reconstructs his motions. Every such change, he adds, is appropriate to its occasion. Every such change, he feels, belongs there. Such feelings are called *insight.*[60] Yet it is the *vivid togetherness* of his motions combined in the new pattern that is the thing, rather than what he has to say about it later.[61]

3. *Closing the gaps in good form.* Perhaps you prefer to speak of a successful typing attitude rather than of insight. If you do, Gregg [62] tells you what this implies. When you pause to plan your movements, when you assume the tentative movements needed for successful typewriting, you gain a typing attitude. Insight merely reflects this successful new attitude. When first confronted by the typing assignment, some of your bodily attitudes are adequate, others are not and call for new, tentative, trial movements

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[59] Bruce, *op. cit.* [60] *Ibid.* [61] Fisher, *op. cit.*

[62] Gregg, F. M., "Materializing the Ghost of Köhler's Gestalt Psychology," *Psychological Review* (1932), Vol. XXXIX, pp. 257–270.

until the copy can be actually typed. As you solve this difficulty in the assigned typing, you feel, "Aha! This is *how* I do it!" Your typing "clicks," which is to say, your muscles are again in suitable, steady balance. This flash of "insight," this unexpected "hunch," this sudden "leap" to a new way with the typewriter and the slight exhilaration that accompanies it are one.[63] As you study your difficulty, stay flexible, and continue to experiment, improvements will appear. The irritants only reveal the gaps in your typewriting. When the successful action emerges, the gap is closed in the direction of "good form."

INTERPRETATIVE SUMMARY

Typing patterns are fitted to the framework of language patterns. These copy patterns may be received through the ear or through the eye. Typing classes are known to go stale with too much copying from copybooks. This is offset by dictation, which launches the typing directly from auditory word signals. Together with other values, this direct dictation, whether oral or by transcribing machine, rapidly cuts down the learning time. Its initial use permits a highly efficient check by the eyes to offset early fumbling with keys, lending finger direction and hastening mastery of the spatial keyboard pattern without recourse to memorized charts or more futile devices. This natural visual aid ceases when the student is ready to read copy and to condition his eyes to cling to copy. The eyes move just fast enough to supply copy to the hand as needed. This "eye-hand span" is usually one word and rarely more than two words ahead of the stroking. Each word outline is completed as a word-whole by the student himself, usually with inner speech. Essentially, copy is a framework built up of a relatively small number of words, arranged in many sentence patterns. This framework supports the longer, more varied, less frequent words. Despite the poor fit of the "universal" keyboard to this framework, its conditioning signals automatically control the forward progression of the typing. Emotional patterns, it should be added, heighten all sustaining tensions. These complete typing patterns, once gradually built in the social setting provided by the typing class, require somewhat similar social settings to maintain their form.

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[63] Bruce, *op. cit.*

While student typists thus advance by variable paths, each seeking new ways to reduce each personal difficulty, the desired outcomes remain fixed — standard typing outputs, both fast and accurate. Personal conditioning, for instance, may lead each student to complete an assignment in a quite different way; yet the class assignment controls throughout. Its consequences impart the necessary stability to the typing practice. A desired standard outcome, once set up, dominates the entire field of the typing class throughout its duration. The general slope of the practice becomes an invisible gradient or line of least possible action to this final desired result. This gradient controls from start to finish. Elimination of action continues until no more elimination is possible, until standard typing is sustained with minimal time and energy.

PART THREE

WORKSHOP DISCOVERIES ABOUT TYPING BEHAVIOR

CHAPTER IX

DISCOVERIES ABOUT MACHINES

* * *

READING SUGGESTIONS

To the Student Typist: Catch the spirit of motion study of your typewriter itself, pages 208 and 209. Read rapidly until you see why the common keyboard interferes with your typing of common words, particularly pages 209 to 228. Apply this to your study of why you make certain errors. (Omit any difficult tables or technical points.) Read to catch the idea of matching your typing with the action of the machine, pages 228 to 230. Read merely to catch the unevenness in some outer keys, pages 230 to 233. Notice the value of a light "touch," pages 231 to 235. Make your study of your typewriter a critical motion study of its action, reading carefully from pages 236 to 239.

To the Psychology Student: Notice how applied motion study includes the machine, pages 205 to 209. You will be interested in the short summary of common language-behavior patterns, page 214; and the way this is used to explain interference with learning common typing motions, pages 212 to 217. You may be interested in attempted removal of this interference as an instance of applied psychology, pages 217 to 228.

To the Typing Instructor: This entire chapter reviews the typewriter. Of special interest are an explanation of the common keyboard as a basic source for student errors, pages 209 to 217; school experiments with a "simplified" keyboard, pages 217 to 228; and use of a consumers' study to acquaint students with the typewriter, pages 228 to 239.

* * *

Handwriting today should be obsolete for many occasions. In its stead the normal human hand, itself a remarkable tool, should be applied to the fast, fluent writing each hour of 3000 words, clearly legible in attractive typescript. The precision of standard typewriters, the ease with which noiseless and portable machines are carried anywhere, the possibility of mastering a simpler keyboard within one half to one fourth the usual practice — all contribute to this end. This valuable personal asset when four times faster than ordinary handwriting is ample for individual writing. If you happen to be a superior typing student, 100 net words a minute should be within reach, if ardently desired.

As you enter a typewriting workshop, the rows of machines lend a more businesslike atmosphere than the usual classroom boasts. Perhaps for the first time in college or school you enter a workroom wherein your ordinary work outputs can be trebled. Perhaps you plunge for the first time into firsthand study of your own motions and of ways to prevent fatigue. You can find more fascinating applied science in this manipulating of a typewriter than in most academic subjects. Your typing studies can change to motion and time studies. Your typing practice can be transformed into laboratory studies of your supply of motions and of your clear, simply written English. In this workroom you can learn in practical ways by watching each skillful motion as the instructor or a slow-motion film *demonstrates*, by class conferences in which questions and answering suggestions are raised until you hit upon superior operating plans, by applying such planning to your *actual typing*, and by a real *checkup* to suggest new ways to operate with less effort in less time.

As you experiment with your own typewriter, you will start to discard innumerable, unnecessary movements as a needless waste of time and energy. You will discover and hold a balanced posture that takes far less energy and causes fewer tired, bored feelings. This finer balance will support your typing. You will discover and practice control, saving just enough tension in your muscles for following copy on your typewriter. You will discover the opposing teams of muscles in fingers and forearm. By relaxing first one and then the other, you will drop any heavy, wooden fingering of the keys. You will see how accelerating finger momentum makes possible the fast, easy stroking called *ballistic*. In fact, all your motions will begin to take loose and easy, direct paths. The moment you discover that two fingers are faster and more accurate than one, you will be feeling successive fingers into positions for the following strokes. These plays for positions will seem the essential feature of typing common words in rhythm. Soon you will prefer to practice regular paces set by machine dictation or by an electric pacemaker or other counting device, until the irregular hesitations between fingers disappear. To facilitate entrance into this successful world of motion study, hidden handicaps in the common typewriter keyboard should be removed. Scanty use of the central row of keys, a mythical "home" row for your fingers; frequent loafing of an entire hand while the other types an entire word; forcing of awkward motions over a fourth of all ordinary typing — such handicaps practically disappear from a "simplified" keyboard.

If you enter with determination upon this fascinating motion study of yourself, you are able to counteract feelings of discouragement over inadequate classroom equipment. A period of nation-wide depression has shown that such irritants provoke the fine effort needed to overcome poverty of equipment. If chairs and tables fail to fit your correct typing posture, that is a problem to be solved. If your typewriter still carries the handicap of an awkward, traditional keyboard, or if its heavy key resistance hinders light, staccato stroking, or if you have no chance to see correct, fast motions demonstrated in slow-motion films — these gaps raise more difficult problems well worthy of your class conferences. Such gaps may hamper but need not stop your study of superior typing motions. This pathway of motion study is already cleared by famous management engineers, the Gilbreths. Along the pathway charted by their notes and writings, it is a rare difficulty that you cannot override or avoid in some practical way.

To live in an age of machinery lends considerable point in centering upon the supply of motions for a machine rather than on an academic text. Unhooded, the modern typewriter may seem complicated if you are not accustomed to machines. Its more complicated details are not of immediate importance. You do not have to be a mechanic to drive your automobile or to stroke your typewriter. Its essential operating details, however, you cannot afford to overlook. Familiarity with the general principles and problems of operating either an automobile or a typewriter sweeps away the fogs of mystery.

EXPERIMENTING WITH A TYPEWRITER'S LIMITATIONS

Discoveries about your machine will appear in lively succession the more you experiment with its possibilities. Shortly you, too, will catch the spirit of motion study. The Gilbreths have quickly sensed serious defects in the present typewriter. Should you like to scan the running stenographic report of such a moment in their experiments?

1. *Gilbreth motion-study notes: the typewriter.* The expert's typewriter is geared up to high speed, and the ordinary operator would find it unsatisfactory.

Speed Coach. I don't think any thought was given to the English end and use of the letters. The majority of the keys most used are on the upper bank. They have given more emphasis to the machine.

Mrs. Gilbreth. The machine can do a great deal more than the average operator can get out of it. The best machines are way ahead.

Speed Coach. The young ladies think that it is the mechanical construction of the machine that is retarding their speed.

Mrs. Gilbreth. In the factories the mechanical end is way ahead of the human end. America has specialized on the mechanical end and let things go haphazard on the human end.

Mr. Gilbreth. I see lots of things the matter with that machine.

Speed Coach. Two thirds of the writing is done with the left hand. The consonants most used are on the left side.

Mr. Gilbreth. What about practice words that are written entirely on the right or left hand?

Speed Coach. There are several thousand words written entirely on the left hand. (*Speed Typist* demonstrates one hand at a time, such as *read* with the left.) *Read* is all on one hand. You see why we have to get after those keys immediately. If you do not, there is a clash.

Mr. Gilbreth. Does not every other typewriter have the same trouble? The answer is that the machine must go as fast as possible. Can the girl beat the machine?

Speed Coach. Not if she fingers properly.

Mr. Gilbreth. Could you imagine a girl going so fast with perfect rhythm that the machine could not get out of the way?

Speed Coach. No.

Mr. Gilbreth. What is the proper tension for the average writer?

Speed Coach. That is a question I cannot answer offhand. There are several ways of adjusting the machine for speed. We can put tension on the keys or carriage. Then we can tension the machine up so it cannot stand any more. There is a limit to the tension on the machine.

A PATCHWORK KEYBOARD

1. *Tolerating the survival of keyboard handicaps.* Although better stroking is the theme of all early practice, the spatial pattern of the "universal" keyboard is your first difficult problem. It is too difficult. This keyboard is a crazy patchwork put together long ago in a series of heartbreaking experiments to fit keys into positions without their colliding or sticking, and so to invent a usable machine. It was put together for a few fingers at a time when no one dreamed of fast, all-finger, touch typing. In those old days an early owner like Mark Twain[1] called it a "curiosity-breeding little joker."

All the early mechanical difficulties have long since vanished in the smooth-running precision of today's standard typewriter. Crude type bars that swung upward under a blind carriage had been transformed even before the turn of the century. A modern type bar now strikes directly in front, to fall swiftly out of the way, or is silently pressed against the paper by your lightest, staccato touch. The heavy capitals that labored straight along now flash up by the magic of a light basket shift. Gone, too, are the queer "sewing-machine" lines of the eighties; the now-forgotten foot throws have advanced to hand throws.[2] Only the patchwork keyboard remains. This accords with the usual commercial policy of withholding improvements as long as current sales are satisfactory.

Many skilled typists who have already compensated handicaps of this keyboard by their own skill, so slowly won, will doubtless continue to operate it for better or worse. In trial practice upon an improved keyboard it does appear that speed per minute is regained in steady increases of 2 net words for each hour of relearning. Any shift to a scientific keyboard at this late date would have to be at the cost of this short period for relearning established spatial relations. In their solicitude for these accomplished typists, the equipment reposing in business houses, and to some extent for their own investment, the typewriter manufacturing companies have not hesitated to sacrifice the increasing armies of learners. By the hundred thousand, you and other new typists must throw away valuable time in a wasteful struggle with needless errors and needless lack of speed forced by this absurd keyboard of the early eighties. It will shortly be shown that probably one half to three fourths of the present learning time is thus wasted in absorbing avoidable keyboard handicaps.

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[1] Mark Twain, *The $30,000 Bequest and Other Stories*, "The First Writing Machines" (Harper and Brothers, 1906), pp. 166–170.

[2] The Smithsonian Institution, Washington, supplies pictures of early typewriters.

The bare recital to you of a few simple facts should suffice to indict the available spatial pattern that is so complacently entitled the "universal" keyboard. Since when was the "universe" lopsided? The facts will not be stressed, since you may finally surmount most of the ensuing handicaps of this keyboard. Just enough facts will be paraded to lend you double assurance that for many of the errors that you will inevitably make and for much of the discouraging delay you will experience in longed-for speed gains, you are not to blame. If you grow indignant over the beginner's role of "innocent victim," remember that a little emotion heightens determination.

2. *Unbalanced left-hand and finger loads.* The so-called "universal" keyboard is obviously a patchwork, even when scrutinized merely by counting the actual usage of isolated letters in written English and by contrasting the efficiency of isolated fingers in tapping. Such a systematic exposure of the keyboard was made by Hoke[3] a decade ago. His work has since been repeated.[4] By counting the number of key strokes for each letter in copy, the loads carried by each typing finger have been roughly uncovered. Suppose you compare the loads of a weaker and a stronger finger. If you compare the weaker little finger of the left hand with the stronger middle finger of the right hand, you find 803 letter strokes plus heavy shift-

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[3] Hoke, R. E., *The Improvement of Speed and Accuracy in Typewriting* (Johns Hopkins Press, 1922).

[4] Riemer, Edwin, "A Revised Keyboard for the Typewriter," Master's Thesis (New York University, 1929).

key strokes all assigned to the weaker, but only 640 strokes assigned to this stronger second finger. If you think there is any rhyme or reason in this, note in Table X, as between your two little fingers, that the left (L–4) does nearly three times the work that the right (R–4) does. Are you able to view these haphazard finger loads in terms of added fatigue, with its errors, and of breaks in the typing rhythm? Lack of proper balance when certain fingers appear overloaded 35% to 53%, while other fingers appear underloaded 26% or even 69%, is hardly a comfortable thought. It is fruitless to continue this ridicule of the "universal" keyboard beyond a glance at Riemer's[8] contrast in Table XII between each finger's tapping ability and its per cent of work while typewriting.

TABLE X

DISPROPORTIONATE LOADS OF THE FINGERS IN TYPING (From Hoke,[5] Riemer[6])

	Left Hand					Right Hand				
Fingers:	L–4	L–3	L–2	L–1	Total	R–1	R–2	R–3	R–4	Total
Key Stroke Loads (Hoke)	803	658	1492	1535	4488	1490	640	996	296	3422
Loads (Riemer)	660	685	1610	1757	4712	1509	636	921	199	3265

TABLE XI

PER CENT OF OVERLOADING AND UNDERLOADING IN EXCESSIVE AMOUNTS FOR CERTAIN FINGERS (From Hoke[7])

	Left Hand				Right Hand			
Fingers:	L–4	L–3	L–2	L–1	R–1	R–2	R–3	R–4
Excessive Overloading . .			53%	49%	35%			
Excessive Underloading		– 26%				– 41%		– 69%

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[5] *Op. cit.*

[6] *Op. cit.*

[7] *Op. cit.*

[8] *Op. cit.*

TABLE XII

TAPPING RATE PER 15 SECONDS FOR EACH FINGER AND PER CENTS OF TOTAL LOAD ASSIGNED EACH FINGER IN TYPEWRITING (From Riemer[9])

	Left Hand				Right Hand			
Fingers:	L-4	L-3	L-2	L-1	R-1	R-2	R-3	R-4
Tapping Rate .	48	57	63	66	70	69	62	56
Relative Tapping Rate .	10	11	13	13½	14	14	13	11½
Per Cent of Typing Load	8	9	20	22	19	8	12	2

You have only to add the key-stroke loads of left and right hands to discover another blow at the balance of the old keyboard. Your lesser left hand must make perhaps 131 strokes to every 100 by the good right hand. (The actual loads for Hoke[10] are 4488 strokes for the left to 3422 for the right.) Riemer[11] estimates similarly that your left hand must make 144 strokes to every 100 by your right hand. Just how much weaker is a left hand in the face of this added burden? Hoke[12] decided to find out by tapping tests for each finger. Tapping both on typewriting keys and on a desk has been timed. High-school and college students have made 89,593 taps with the left hand and, in equal time, 100,817 taps with the right. The proportion is 89 to 100. This *raises the load of the left hand to 147%,* as compared with 100% for the right. Here is a left-handed typewriter in a right-handed world! To confirm these tapping rates, Riemer[13] asked a high-school class after six weeks of typewriting to take finger positions on the home row and tap each key fifteen seconds. Again the proportion was only 90 to 100. These tapping tests agree that the usual left hand possesses only .9 of the speed and strength of the right hand.

3. *Excessive interference with common typing sequences.* Since typewriting is far more than simple tapping of isolated keys, as reported by Hoke[14] and Riemer,[15] and since their method of count-

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[9] *Op. cit.*
[10] *Op. cit.*
[11] *Op. cit.*
[12] *Op. cit.*
[13] *Op. cit.*
[14] *Op. cit.*
[15] *Op. cit.*

ing loads is incomplete, this exposure of a shocking unbalance between fingers and a 47% overload upon the left hand seems lenient As a matter of fact, the "overloaded" keys do not directly sink under an overwhelming excess of inaccuracy. Not a few overworked key strokes, on the contrary, appear relatively more accurate Isn't this another paradox? It merely illustrates the fact that isolated key strokes have little, if any, influence, whereas the most common word combinations are able to hold down much keyboard interference. As a result, the interfering on the part of a continuous keyboard handicap is often indirect. When the loads and relative efficiency of strokes of the various keys are lumped together for each finger, as you see in Table XIII, any relationship between finger load and relative efficiency of the finger disappears. Later you will discover surprising excesses of errors from the stronger fingers covering central keys, even in the home row. These actual excessive errors, however, will be traced only indirectly to overloads Although this analysis of such overloads is enough to condemn the present unbalanced keyboard, further studies show that the rea picture is far more serious.

TABLE XIII

Ranks of Eight Fingers in Finger Loads and in Relative Freedom from Letter Errors (From Hoke[16])

	Left Hand				Right Hand			
Fingers:	L-4	L-3	L-2	L-1	R-1	R-2	R-3	R-4
Finger-load Rank . . .	5	6	2	1	3	7	4	8
Relative Finger Efficiency . .	8	7	3	4	6	5	1	2

Shortly, as you discover facts about errors, you will find tha even superior second-year students seem unable adequately to overcome further handicaps of the present keyboard. Its underlying interference is inescapable, because the arrangement of the keys renders awkward the actual stroking in many of the most common words.

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[16] *Op. cit.*

What, then, are these common combinations which your fingers must follow? The shortest sequence in your stroking obviously is the two-letter combination known as a *digraph.* The actual usage of English digraphs and longer sequences counted by Rowe,[17] for example, from the Horn list of 1000 commonest words exceeds 75,000,000. Typed English is made up almost entirely of these digraphs combined as words. Have you realized that 11 digraphs alone make up nearly one fourth of all your ordinary typing copy? Of the millions of digraphs regularly typed in everyday words, only 34 digraphs make up one half of such copy; only 57 digraphs make up three fourths; only 137 make up 90%. Accordingly, typewriter keys should be arranged to give these few digraphs the fastest and most effective setups available for successive stroking. Have you realized that, in like manner, nearly one half of your ordinary typing copy is merely 104 three-letter combinations known as trigraphs, or simply 208 four-letter combinations? When the "universal" keyboard was set up, however, no attempt was made to fit this written English. Whether or not these few digraphs, which make up the bulk of ordinary copy, could be efficiently stroked was left to chance. As a result, some can and others decidedly cannot be stroked with efficient ease. This failure is readily pictured in terms of common digraphs. Before describing present interference in detail, it should be said that approximately 28% of all digraphs which you type are forced by the "universal" keyboard into more or less awkward, or less effective, serial stroking. Of course these handicaps operate to produce errors and to reduce your fluency.

When you listen to a fast typist using the "universal" keyboard, you can note either breaks or the lack of a perfect rhythmic pace. This uneven rhythm is forced whenever a typist capable, say, of typing 80 words per minute when both hands stroke alternately comes to copy in which large parts must be typed with one hand alone. In such words as *greatest*, *minimum*, *were*, *sadder*, *saddest*,[18] for example, the inevitable effect is an undesirable break in pace. Either the hand taking up such portions of the copy must speed up to an amount nearer 160 words per minute on copy typed with both hands or the speed temporarily must drop closer to 40 words per minute. This frequent idling of an entire hand while the other hand does double duty is a striking feature in "slow-motion" pictures of usual typewriting. In fact, the slower fingering combinations that employ the same hand amount to nearly half of all digraphs which you type on the common keyboard. Words typed with the same hand, moreover, are heavily overloaded in the left hand, whereas right-hand digraphs would usually be somewhat faster and more accurate. All this excessive absence of what should be faster patterns stroked by fingers of opposite hands automatically lowers your speed.

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[17] Rowe, C. E., "Importance of Two, Three, Four, and Five Letter Combinations on the Basis of Frequency in a Word List," Master's Thesis (University of Pittsburgh, 1930).

When two-finger stroking is forced into the same hand, however, it is important that certain common digraphs be stroked by remote fingers. The play between fingers adjoining one another, especially in the case of the little and ring fingers, is less rapid and effective, as a rule, than the play between remote fingers. This is peculiarly true if the digraph moves outward from a stronger to a lesser finger. Adjacent mistakes, too, make up the bulk of errors. Despite the fact that digraphs stroked by remote fingers (and by opposite hands) are usually faster, nearly a fifth of the digraphs you must type on the "universal" keyboard employ adjacent fingers.

Even though idling by your entire hand is far more extensive and serious, the occasional forcing of one finger to type an entire sequence inflicts very striking and indefensible damage to speed and rhythm. Any digraph stroked with the same finger obviously is one of the slowest, poorest sequences in typing. On the "universal" keyboard, more than 4% of your two-letter combinations must be tapped with the same finger.

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[18] Try typing these words: *afterwards*, *aggravated*, *desecrater*, *effervesces*, *exaggerated*, *million*, *monopoly*, *reverberates*. A dictionary count reveals 3000 words typed by the left hand.

Among such digraphs, which reduce typing to mere finger tapping, what is your prime notion of awkward fingering? Undoubtedly, it is outright finger hurdling to keys in upper and lower banks. In general, the crowding of most common fingering combinations out of the home row and into one hand has an unforeseen result. The "guide" keys must be abandoned while the fingers play between upper and lower banks of keys. Fully one sixth of the digraphs in your usual typewriting force this more or less awkward serial stroking across the barrier of what curiously enough is alleged to be a home row.

In fact, you may already have noticed that most of your typing actually is on the upper row of keys. In your overlapped stroking fully 85% of digraph combinations must touch the upper row of keys. Literally, this upper bank is your home row if "home" is where your fingers abide! Nor is there any apparent reason why so many common combinations should touch this upper bank. What is apparent is the prodigal waste of your motions. Indeed, as suggested in the earlier criticism of hurdles between outer banks, about 30% of your digraph stroking must touch the lower bank of keys, which is usually slow.

What is left of the home row? Little more than one half of your successive stroking even partly touches these more efficient home positions. Only 7% of your digraphs, in fact, are entirely in it. This lack of any genuine home row to receive and speed the bulk of your typewriting clinches the unfitness of the "universal" keyboard for college and school instruction.

You have just read approximate estimates of the kind of reaches and hurdles unduly forced into all your typewriting by the haphazard keyboard arrangement in common use. Without such analysis, the dramatic extent of these handicaps remains invisible. Perhaps the conscientious student typist even fears that he himself is at fault. Your study of this analysis could be continued by slow-motion pictures of expert typewriting. These reveal vividly the absence of any actual home row, the repeated idling of one or the other hand, the continuous forcing of excessive motions, not merely of fingers but of entire hands and forearms, even with the typing expert. The general indictment of the "universal" typewriter keyboard, as already made, remains simply this: its arrangement of key locations has scant reference to the adaptability of your hand skills to the sequence patterns of the written language.

4. *Better balanced keyboards.* The traditional keyboard has recurrently stirred suspicion in the past. As you would expect, attempts to reduce this disturbing irritant have followed. The rising pressure from the typewriter's phenomenal spread into daily life and from the superior speeds increasingly sought in touch typewriting is breaking down the inertia that still supports the outworn keyboard tradition. Tentative revisions of the keyboard have been drawn by Hoke,[19] with more equal finger loads; by Riemer[20] and by Rowell,[21] with most frequent letters in the center; by Wolcott,[22] with least frequent letters in the center; by Gilbert,[23] with elimination of hurdles; by Nelson,[24] in a handwriting pattern; by Banaji,[25] from India; and by Ostrey,[26] with a uniform angular deviation of the keys. Subjected to the basic test of common digraph usage, none of these previous keyboards seems to give an adequate fit between stroking sequences and language sequences.

Analysis of the present keyboard is so destructive that an improved arrangement is a modern imperative. Isn't it obvious that faster, more accurate, less fatiguing typing can be attained in much less learning time provided a simplified keyboard is taught? Studies by Dvorak and Dealey,[27] accordingly, employing sequence counts that are statistically adequate, have led to a simpler design of key locations. This design fits hand-stroking skills to the sequence patterns of English copy. Comparisons should indicate to you the superior operating ease that naturally flows from a "simplified" design.[28]

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[19] Hoke, R. E., "Typewriter Keyboard Arrangement," Specification of Letters Patent, U. S. Patent Office, No. 568,792, 1924.

[20] Riemer, Edwin, *op. cit.*

[21] Rowell, S. W., "Typewriter Keyboard," Specification of Letters Patent, U. S. Patent Office, No. 943,466, 1909.

[22] Wolcott, C., "Keyboard," Specification of Letters Patent, U. S. Patent Office, No. 1,342,244, 1920.

[23] Gilbert, W. A., *The Orthographic Keyboard* (Shaw and Borden Company, 1930).

[24] Nelson, W. W., "The Improvements in Connection with Keyboards for Typewriters," British Patent, No. 155,446, 1920.

[25] Banaji, F. M. M., "Keyboard for Typewriters," Specification of Letters Patent, U. S. Patent Office, No. 1,336,122, 1920.

[26] Ostrey, J. M., "A Critical Analysis of Letter Sequences in Typewriting," Master's Thesis (University of Nebraska, 1929).

(1) Your more usual comparison — of the relative finger and hand loads — now reveals a left hand relieved of its overburden. The "universal" keyboard load for this slightly weaker hand, amounting to 56% of all stroking, is cut to 46%. The slightly stronger hand assumes its due share of work. It no longer idles over a "universal" keyboard with only 44% of the stroking. It now strokes 54% of the copy. The balanced hand loads (see Table XIV) now closely approach the hand efficiencies.

TABLE XIV

RELATIVE FINGER AND HAND LOADS ON THE "UNIVERSAL" AND ON THE "SIMPLIFIED" KEYBOARD

	Left Hand					Right Hand				
Fingers:	L-4	L-3	L-2	L-1	Total	R-1	R-2	R-3	R-4	Total
"Universal" Keyboard	7.9	7.8	17.8	22.2	55.7	20.9	8.4	13.3	1.7	44.3
"Simplified" Keyboard	8.3	10.0	13.6	13.8	45.7	17.9	14.8	13.0	8.6	54.3

The reductions apply not only to left-hand finger loads but also to left-hand words. The faster stroking by fingers of opposite hands has been built up to cover two thirds of all ordinary typing. This is now 67% as compared with the former 48%. Since every syllable must have a vowel, the new keyboard (see Figure 5) concentrates the vowels in the left hand, together with the common punctuation marks and the less-used consonants, *p*, *y*, *q*, *j*, *k*, *x*. Thus no word or syllable can be typed with the right hand alone. Only a

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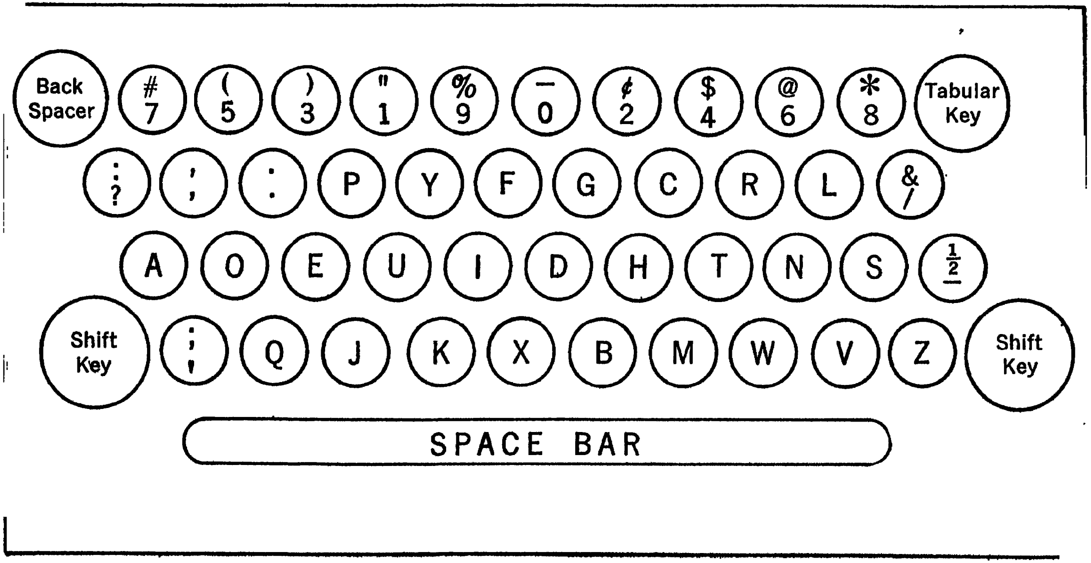
[27] Dvorak, August and Dealey, W. L., Unpublished Experiments, University of Washington, 1931–1935.

[28] Dvorak, August and Dealey, W. L., "Simplified Keyboard Arrangement," U. S. Patent Office, Serial No. 612,738, 1932.


Back Spacer
# 7
(5
) 3
" 1
% 9
— 0
¢ 2
$ 4
@ 6
* 8
Tabular Key
: ?
; ;
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P
Y
F
G
C
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& /
A
O
E
U
I
D
H
T
N
S
½
Shift Key
; ;
Q
J
K
X
B
M
W
V
Z
Shift Key
SPACE BAR

Figure 5. Dvorak-Dealey "Simplified" Typewriter Keyboard
(Copyright and patented 1932 by August Dvorak and W. L. Dealey[29])

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[29] *Op. cit.*

relatively small number of common words or syllables can be typed with the left hand alone. Such digraphs as include different fingers in the same hand are in the main arranged to overlap from outer to inner fingers.

On the "universal" keyboard, incidentally, the relative finger loads have long been pictured as neither equal nor proportionate to the different finger skills. Instead, the "universal" finger loads rather shockingly deviate. For the "simplified" keyboard, the ranks of each stroking load assigned each finger exactly follow the ranking for each finger's ability (see Table XV). Digraphs stroked with both the more easily tired fourth and fifth fingers, for further example, have been cut down (from 3% to 1%). Typewriting as a whole is no longer slowed by left-hand and finger delays due to excessive demands, but instead is more smoothly balanced.

TABLE XV

RELATIVE RANKS OF FINGER SKILLS (FROM RIEMER[30]) AND COMPARISON OF TYPING LOADS ON THE "UNIVERSAL" AND ON THE "SIMPLIFIED" KEYBOARD

	Left Hand				Right Hand			
Fingers:	L-4	L-3	L-2	L-1	R-1	R-2	R-3	R-4
Rank on Skill (Riemer)	1	3	5	6	8	7	4	2
Rank on Load ("Simplified" Keyboard) .	1	3	5	6	8	7	4	2
Rank on Load ("Universal" Keyboard) .	3	2	6	8	7	4	5	1

(2) Your second and vital comparison, drawn from elaborate word counts of running copy and stated in Tables XVI and XVII, shows a frequency of some ten and a half million digraphs stroked by awkward, fatiguing, time-consuming finger reaches and hurdles on the "universal" keyboard. This tremendous total has been reduced to only one and a half million digraphs similarly stroked on the "simplified" keyboard. This is a reduction greater than

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[30] *Op. cit.*

TABLE XVI

RELATIVE NUMBERS AND FREQUENCIES OF DIGRAPHS STROKED BY AWKWARD HURDLES AND REACHES ON THE "UNIVERSAL" KEYBOARD

(Frequencies are listed in units of 10,000 in 37,000,000.)

Stroking Pattern		Left Hand		Right Hand		Total	
		No.	Frequency (10,000's)	No.	Frequency (10,000's)	No.	Frequency (10,000's)
Same Finger	Hurdles . . .	2	39	4	35	6	74
	Reaches . . .	6	66	3	30	9	96
Adjacent Fingers	Hurdles .	5	105	2	103	7	208
	Reaches .	11	436	7	117	18	553
Remote Fingers:	Hurdles .	1	1	3	113	4	114
Total		25	647	19	398	44	1045

TABLE XVII

RELATIVE NUMBERS AND FREQUENCIES OF DIGRAPHS STROKED BY AWKWARD HURDLES AND REACHES ON THE DVORAK-DEALEY "SIMPLIFIED" KEYBOARD

Stroking Pattern		Left Hand		Right Hand		Total	
		No.	Frequency (10,000's)	No.	Frequency (10,000's)	No.	Frequency (10,000's)
Same Finger	Hurdles . .	1	1	1	1	2	2
	Reaches . .	5	22	6	26	11	48
Adjacent Fingers	Hurdles .	0	0	1	5	1	5
	Reaches .	6	44	7	37	13	81
Remote Fingers:	Hurdles .	0	0	3	10	3	10
Total		12	67	18	79	30	146

85% in the direction of more relaxed, more rapid, and more accurate typewriting learned in less time.

The "simplified" keyboard is the inevitable result of the application of the Gilbreth efficiency engineering analysis of motion study to typewriting. Whenever the intricacy or complexity of a series of motions required of an operator is reduced, the performance of the series is easier to master and the frequency of false motions decreases.

Certain details of this reduction may be informally summarized. The more or less awkward fingering combinations largely eliminated include:

Stroking Patterns	“Simplified”	“Universal”
(*a*) Digraphs stroked as adjacent-finger hurdles	0.1%	5.6%
(*b*) Digraphs stroked as remote-finger hurdles	0.2%	3.0%
(*c*) Digraphs stroked by hurdling with the same finger	0.0%	2.0%
(*d*) Digraphs stroked by the same finger .	1.3%	4.7%
(*e*) Digraphs stroked by less effective adjacent fingers	2.3%	20.6%

The more or less awkward interplay between adjacent fingers, with its mass of errors, is reduced some tenfold. Absurdly slow, successive taps by the same finger are reduced some fourfold; and its hurdling, which is the worst sequence in typing, is practically ended. Hurdling across the middle or home row has virtually disappeared. In short, one fourth of all ordinary typing no longer is needlessly handicapped.

(3) Your third vital comparison of the actual stroking sent into the less efficient upper and lower banks of keys, as made in Table XVIII, is equally illuminating. On the “universal” key-

TABLE XVIII

Relative Distribution in Per Cents between the Three Key Rows (*a*) of Actual Letter and Punctuation Strokes in Ordinary Copy and (*b*) of Digraphs in Ordinary Copy That Include the Row, on the “Universal” and on the “Simplified” Keyboard

Banks	Per Cent of Actual Strokes		Per Cent of Digraphs that Include the Row	
	“Simplified” Keyboard	“Universal” Keyboard	“Simplified” Keyboard	“Universal” Keyboard
Home Row . .	70%	32%	96%	51%
Upper Row . .	22%	52%	35%	86%
Bottom Row . .	8%	16%	16%	30%

board, you may recall that only 7% of all the digraphs in ordinary copy are stroked entirely on what is erroneously termed its home row. Hardly one third even of the key strokes in running copy strike this middle or home row. The remaining two thirds are stroked on upper and bottom rows. The resulting hurdles across the middle bank have already been condemned. Many digraphs which do include the middle row have already been criticized for using adjacent fingers on keys of two rows. By sharp contrast, the placement of 70% of running copy strokes in the home row on the "simplified" keyboard must result at once in more rapid learning and easier operation. Almost all the digraphs

TABLE XIX

COMPARISON OF ATTAINMENTS OF STUDENTS TAUGHT TO TYPEWRITE ON MACHINES EQUIPPED WITH DVORAK-DEALEY "SIMPLIFIED" KEYBOARD WITH ATTAINMENTS OF STUDENTS TAUGHT ON THE "UNIVERSAL" TYPEWRITER KEYBOARD[31]

"SIMPLIFIED" KEYBOARD

Classification	Average Number of 50-Minute Instruction Periods	Average Attainment *	Gain in Net Words per Instruction Period
9 High-school students .	36	40 net words per minute	1.11
12 High-school students .	38	43 net words per minute	1.13
44 University and adult students	26	32 net words per minute	1.23
39 Junior high-school students	24	19 net words per minute	.80
8 Adult students with previous typing experience	29	58 net words per minute	2.00
104 Beginning students	27.5	29.1 net words per minute	1.06

* Attainment in net words per minute, measured in accord with the International Typewriting Contest rules.

[31] Uhl, W. L. and Dvorak, August, "Cost of Teaching Typewriting Can Be Greatly Reduced," *The Nation's Schools* (1933), Vol. XI, pp. 39-42.

TABLE XIX — *Continued*

"UNIVERSAL" KEYBOARD

	Number of Instruction Periods	Average Attainment	Gain in Net Words per Instruction Period
Usual high-school requirement for credit . . .	90	18 net words per minute	.20
Average high-school attainment	90	25 net words per minute *	.28
Usual high-school requirement for credit . . .	180	30 net words per minute	.17
Average high-school attainment	180	35 net words per minute	.20
Superior high-school attainment	180	40 net words per minute	.22
Washington state championship score (1934) .	180	58 net words per minute	.32
Washington state championship score (1934) .	360	72 net words per minute	.20

* A lower estimate, such as 20 net words, would be closer to public-school reality. In Owens' first-year typewriting survey of more than 4500 students in 44 high schools, the sample January tests averaged only 14 words, and the tests in late May, 25 words.[32] Data for California schools, by Kibby,[33] give maximum mean attainments of 16, 29, 37, and 42 net words per minute, respectively, for 1st, 2d, 3d, and 4th semester typewriting classes taught 50 to 60 minutes daily.

typed thus include the home row, and 45% never leave its keys. Most of your typing can now run swiftly in the home row. You can use a genuine home row for high-frequency digraphs. These middle keys now present a more apt analogy with the continuous piano keyboard. Even though light, staccato typing differs from the more rapid legato possible on the piano, the greatly increased play of fingers over "position" keys should release high speeds hitherto impeded by the "universal" keyboard.

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[32] Owens, C. B., "Standards in Typewriting," *American Shorthand Teacher* (1930), Vol. XI, pp. 89–98.

[33] Kibby, Ira W., "A Study of Typewriting Accomplishments in California Secondary Schools," Mimeographed Report, State Department of Education, Sacramento, California, March, 1933.

An initial demonstration on the new keyboard of its decreased learning time, reduced errors, speed increases, and superior fluency has surpassed sanguine expectations. This "simplified" keyboard was tested with an experimental class of 83 students at the University of Washington during the summer of 1932. You will be interested, to say the least, in an informal comparison of student achievement using the new keyboard with the customary attainment of high-school students who use the "universal" keyboard.

Summary: on the "Simplified" Keyboard after Varying Portions of a Forty-five Period Course of Instruction

Of 21 high-school students	11 reached 40 or more net words per minute
	19 reached high-school credit attainment for 180 days
	21 reached high-school credit attainment for 90 days
Of 39 junior high-school students	1 reached 40 or more net words per minute
	5 reached high-school credit attainment for 180 days
	19 reached high-school credit attainment for 90 days
Of 44 university and adult students	10 reached 40 or more net words per minute
	25 reached high-school credit attainment for 180 days
	36 reached high-school credit attainment for 90 days

The general gain of 1.1 net words per minute for every "hour" of practice, under optimal experimental class conditions, appears fully four times the usual gain of 0.2 net word per minute for every "hour" in the conventional high school on the old keyboard. What is your usual gain for every fifty minutes of practice? With the new, "simplified" keyboard the gains in attainment (see Table XX and Figure 6) for 250 junior and 110 senior high-school students who attended 45-minute and 55-minute instruction periods for one and two semesters in the Tacoma, Washington, public schools under ordinary school conditions, while not equal to University of Washington experimental class attainments, were still two to three times the attainments on the "universal" keyboard as found in three nationally known studies. The contest attainments

TABLE XX

TYPEWRITING ATTAINMENT SCORES ON THE "UNIVERSAL" KEYBOARD IN NET WORDS PER MINUTE IN JUNIOR AND SENIOR HIGH SCHOOL, AND TYPEWRITING ATTAINMENT SCORES ON THE "SIMPLIFIED" KEYBOARD AS FOUND IN THE CARNEGIE FOUNDATION STUDY

		Senior High School				Junior High School	
Keyboard:		"Universal"			"Simplified"	"Universal"	"Simplified"
Study:		Kibby (a)[33]	Kochka[34]	Carmichael (b)[35]	Carnegie Foundation (c)	Kibby (d)[33]	Carnegie Foundation (e)
Semester	Percentile						
I	0	0			21	0	17
	25	10			31	4	22
	50	16.5			37.5	10.6	27.1
	75	23			45	16	31
	100	52			70	52	44
II	0	0	10		33	0	23
	25	22	21		42	15	30
	50	28.4	26.1	25.6	48	21.4	36.1
	75	36.5	33		57	29	42
	100	70	59		83	55	49
III	0	0	21			0	
	25	30.5	31			20	
	50	35.5	35	34.4		26.8	
	75	42.5	40			35	
	100	64	64			67	
IV	0	0	25			0	
	25	35.5	36			25	
	50	40.9	41	39.3		33.4	
	75	47.5	46			40	
	100	76	66			58	
V	0		31				
	25		41				
	50		45				
	75		49				
	100		69				
VI	0		34				
	25		42				
	50		47				
	75		52				
	100		72				

(a) An average of figures given for 50 to 60 minute periods in 1931 and 1932.
(b) An average of figures for schools of different classifications.
(c) Data secured from high-school classes meeting 55 minutes daily.
(d) An average of figures given for 40 to 50 minute periods in 1931 and 1932.
(e) Data secured from junior high-school classes meeting 45 minutes daily.

[33–35] For references, see pages 224 and 227.

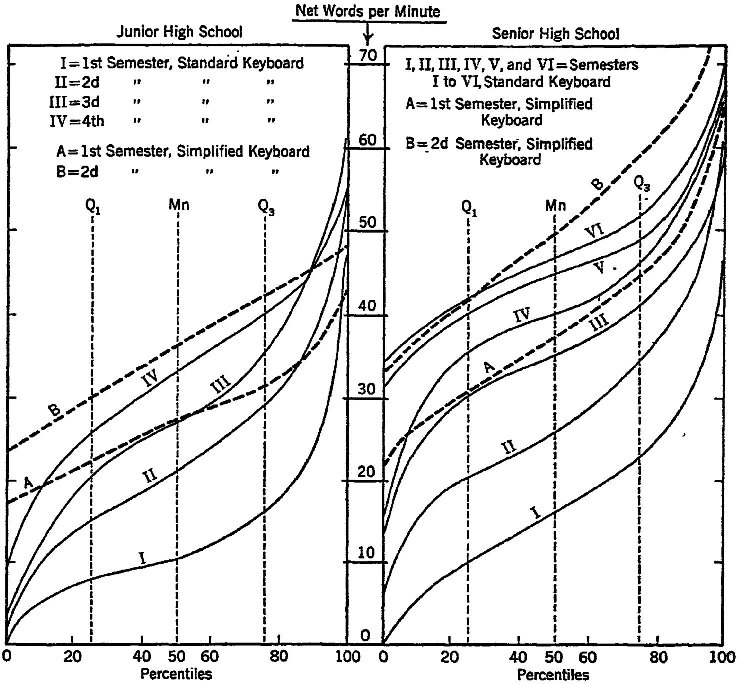

Figure 6. Percentile Graphs Illustrating Comparative Attainments in Net Words per Minute on the "Universal" and on the "Simplified" Typewriter Keyboards (Data illustrated for "Universal Keyboard" represent a composite mean of scores found by Kibby,[33] Kochka,[34] and Carmichael.[35])

of students using the "simplified" keyboard in competition with students using the "universal" keyboard likewise bear out the claim that the "simplified" keyboard takes less time to master.[36]

[34] Kochka, Joseph L., "Norms of Achievement in Speed and Accuracy in Typewriting, *Balance Sheet*, January, 1934, pp. 199–206.

[35] Carmichael, V. H., "Objective Measurement of Accomplishment in Typewriting of High School Commercial Pupils in Indiana," Monographs in Education, No. 12, University of Iowa, *Research Studies in Education*, 1932.

[36] At the International Commercial Schools Contest, 1933, three students after six months' instruction or less won one first place, two second places, and one third place. In 1934 three students won three first places, two second places, and two third places. In 1935, nine students entered won seven first places, seven second places, and six third places.

This great saving in learning time serves to emphasize and guarantee the conclusion advanced by Freeman[37] that the typewriter offers a new and more fluent mode of written expression. The spread of personal typewriting already represents a large social movement; yet to date schools have done little toward developing this individual use of typewriters for private life. For the typewriter manufacturers, the possibilities of the typewriter outside the commercial field are a relatively new venture. The expanding field of the portable typewriter lies almost entirely with private, or personal, typing. Yet the portable typewriter with the "universal" keyboard offers identical delays to adequate mastery. It is expected that a simplified keyboard will be the solution to many of the problems which otherwise confront you, your instructor, and the manufacturer of your typewriter.

FITTING MACHINES TO TYPISTS

The moment you cease to be distracted by a first contact with an unfamiliar keyboard, you will want to concentrate on correct, fast key stroking. You must first graduate, however, from slow "key-finding" motions into typewriting. This transition is clearly depicted by Crooks[38] with the added suggestion that you experiment with different blows. By these actual tryouts you soon discover that the faster you make the blow the quicker the typebar action. You continue this problem solving. You discover with the faster blows that nearly all motion disappears into the release of your fingers from the keys. Did you suspect this paradox, that stroking is *from* even more than *to* the keys? In order to explain this point, you meet another disconcerting discovery about your machine.

Each typewriter is geared to a nice balance between the speed of its carriage and a certain stroking speed. Since no one student's strokes are quite like another student's, a nice balance between typist and machine is seldom present. If your typewriter does not accurately fit your stroking, maybe the fault is not entirely yours. The better adapting of typewriters to typists is an open problem for the manufacturers.

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[37] Freeman, F. N., "Experiment in the Use of Typewriters in the Elementary School," *Elementary School Journal* (1932), Vol. XXXII, pp. 752–759.

[38] Crooks, Maxwell, *Touch Typewriting for Teachers* (Sir Isaac Pitman and Sons, 1931), pp. 47–57, 68.

First observe as one complete interval the time between two successive strokes.[39] This time is set by the skill of your fingers. In the second place, observe the separate interval between the release of one key and the engaging of another by the machine itself. This time is set by the action of the machine. It is a tiny but constant fraction of a second, depending on each typewriter. The analogy is of two machines, the typist and the typewriter, working in unison. Obviously, the rhythm of the second machine, your typewriter, must fit into the rhythm of the first machine, your stroking fingers.

These details may be clearer if you experiment a bit with uneven stroking. Watch the definite points where ribbon and carriage are set in motion.[40] Stroke the space bar slowly to watch the ribbon carrier and then the carriage motion. Stroke a letter key slowly to watch the ribbon, carriage, and type bar meet at the striking point. Try any two strokes, say *jk*. Hold the *j* stroke down overlong, then quickly strike *k*. What happens? Do you lose the *k* entirely or is it poorly spaced or lightly imprinted? Now try the two strokes almost at the same time. Do the type bars pile up? Do you see clearly how the machine requires a minimum time to get the carriage into position and clear the last type bar out of the way? The future exception may be the space-bar stroke. By a recent invention mentioned by Crooks,[41] each word's final letter stroke and the thumb operate at the same time. Such exceptions would operate to increase rather than simplify skill.

In studying this minimum time between your key stroke and the machine's action, what you would miss is the unfelt and accordingly unnoticed arrest of your finger as it strikes a key. This contact time while the finger halts upon the key varies with typists.

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[39] Lahy, J. M., "Le Facteur Psychologique dans la Construction des Machines à Écrire," *Année Psychologique* (1927), Vol. XXVIII, pp. 245–247.

[40] Crooks, Maxwell, *op. cit.*, pp. 68, 90–91.

[41] Crooks, Maxwell, *op. cit.*, p. 65.

Although the duration of this arrest is not even felt, it must be the shortest pause which can be held and yet preserve the succession of strokes. Does this explain your fast getaway? To cling to the key invites a clash with the machine. The carriage is not in position for the next stroke. The mere fraction of a second required by the machine is cut short by your next overlapping stroke. The impression of the next letter falls to the left. The writing looks and is irregular. If this contact pause on the key is overshortened, the imprint of the key cannot develop and the writing is indistinct. If the strokes overlap too closely, the keys pile up.

In order to achieve this clever balance between the timing for your fingers and the quicker timing in between for the machine, you discover *ballistic* stroking. This stroke is not chiefly a hammer blow, with your finger tip as a little hammer thrown at the key, and not chiefly a snatching motion, but a movement akin to both. You develop it by striving only for the quickest possible rebound away from each key. Were you to try to think of striking the key with a snatch or like a hammer, the muscles that start your finger would fail to relax. When you think only of speed in your finger's rebound from the key, these starting muscles very likely do relax. The finger flies loosely of its own momentum until caught by the opposing muscles and thrown back with the slightest arrest. Do you see, incidentally, why the greater rapidity of some machines is of no advantage unless fairly fitted to the speed of your getaway in stroking?

COMPENSATING FOR MECHANICAL DIFFERENCES

1. *Uneven resistance of outer keys.* Interference from the machine itself can be very obvious if you must capitalize with a strenuous shift key. Although a light basket shift bringing so-called "shift freedom" moves only the type bars, some makes of typewriters have a heavy capital shift that raises the full carriage. Ordinarily, this stroke trebles the usual letter-stroke time. It brings special tension and probably the added peril of taking the hand partly out of position. Of course this type of interference

disappears when the capital shift and the carriage return are electrically operated.

There are, however, less obvious resistances in the more humble letter keys. These you may vaguely sense as irritation over uneven typing arising from uneven resistance at certain keys. Let a delicate apparatus be fitted to strike each key a uniform blow. Let it be fitted to measure exactly the depth of the key's depression and any rebound. Suppose the typewriter to be freshly cleaned and nearly new. Bramesfeld[42] has measured such a typewriter by such a device. The keys not only appear uneven in their varying resistance to this uniform blow, but also differ markedly. Another keyboard paradox appears. The weaker fingers, notably of your left hand, probably stroke against stronger key resistance. The stronger fingers probably stroke against weaker resistance. In order to bring something like evenness into typewriting upon this particular machine, your weaker fingers must thus compensate by more intense strokes. Notice the plight of the little left finger of this relatively new machine. Its *q* stroke requires nearly twice the effort for an *e* stroke or a *t* stroke. The much-used *a* stroke requires almost half again as much effort as certain strokes by the strong index finger. Notice the similar plight of the weaker third finger (left) in compensating for extra resistance from the *s* key. Or turn to the home-row keys in the very center of the keyboard. Obviously the index fingers must vary their strokes in the proportions of 15 : 13 : 14 : 12 (Table XXI).

With a finger, tap lightly along a row of keys upon your own typewriter, striking each with the same light touch. Even with this crude approximation probably you feel distinct differences in the resistance between inner *versus* outer keys. Such key resistances seem for the most part usual to those "standard" machines which do not carry rigid type bars with ball bearings. What happens to an old machine with its type-bar action clogged with eraser dust — if erasers are not correctly handled in your classroom? With that machine, wouldn't evenness of stroking realize a near miracle?

[42] Bramesfeld, E., "Untersuchung des Anschlags an der Schreibmaschine," *Industrielle Psychotechnik* (1929), Vol. VII, pp. 226–227.

TABLE XXI

DEPTHS WHICH KEYS ARE DEPRESSED BY A UNIFORM BLOW: RELATIVE PER CENTS OF EFFORT REQUIRED OF THE SEPARATE FINGERS (From Bramesfeld[43])

Letter Keys and Depths Depressed									
3.3	15.7	16.5	15.7	16.5	15.7	15.7	16.5	15.7	15.0
q	w	e	r	t	y	u	i	o	p
10.5	11.2	10.5	15.0	13.5	14.2	12.8	15.0	14.2	14.2
a	s	d	f	g	h	j	k	l	;
10.5	10.5	12.8	12.8	12.8	12.8	13.5	12.8	12.0	10.5
z	x	c	v	b	n	m	,	.	/
Relative Per Cent of Effort for Each Finger									
100%	78%	73%	67%	68%	68%	69%	66%	70%	73%

This usual unevenness between separate keys disappears in the recent far-reaching mechanical advance known as the "noiseless" typewriter. A "noiseless" machine would help promote your correct stroking, because its operation depends upon a light, staccato blow. This light blow undergoes an automatic change too fast for the human eye to follow unaided. This is effected through a key counterbalance in the mid-section of an elaborately equipped type bar. If slowly depressed, the type bar will not touch the paper. If you strike the key in staccato fashion, however, the energy of your finger stroke is transferred to the key counterbalance weight. Momentum accumulates in this weight and carries the type bar forward to the paper. The result is "pressure" typewriting. Each staccato blow is smoothly pressed against the paper with an even imprint. This mechanical contribution towards greater ease of stroking contrasts sharply with continued use of an awkward keyboard.

In the development of a light, *ballistic* stroking, noticeable interference is just around the corner when your classroom is equipped with heavy-touch machines. A heavy stroke acquired by practicing a "standard" typewriter having considerable key resistance is not adapted to the lighter "standard" and "noiseless" machines. Your later transfer to a lighter-touch machine will be accompanied by considerable discomfort. Transfer from a light to a heavy-touch machine, however, is more readily made. For this reason, some typing classes would equip you at the outset with a machine of light touch and easy action, so that a slight, staccato stroking is developed from the start. Both ease of operation and initial cost roughly follow the ascending series of "portable," "standard," "noiseless" machines. As would be expected, ease of operation is greater, but the noise of key strokes is far sharper in an electric-drive typewriter. Here you merely indicate the key by a slight touch, and the machine completes the greater share of the stroking.

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[43] Bramesfeld, E., *op. cit.*

2. *Interference from mechanical differences between typewriter models.* Surprising differences in the resistance of different typewriters are best offset by studying the energy cost of your typewriting. From random business letters, Norton[44] has measured the sum of work needed for every operation on the typewriter. The pressure that you must apply to the machine for typing a business letter about equals the work of mounting one step on the stairs. Actually, you tire more from the support of body weights, such as your working forearm and hands, also from the use of small, fine, manual muscles. Compare the measurements of these various typing operations by Norton[45] in Table XXII. Each carriage return consumes a large amount of work. In typing the usual business letter, the carriage throws about equal the work expended on the keys. For you to move the carriage 24 times is less tiring, however, than to stroke the keys 700 times. About one half the pressure needed for a type key operates the space bar with its shorter stroke and lighter resistance. The pressure needed to operate the large mass of the usual capital shift is about three times as great as for the type key. After finding the highest efficiency for each separate

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[44] Norton, F. H., "The Work Required to Operate Several Makes of Typewriters," *Transactions* (American Society of Mechanical Engineers, 1927–1928), pp. 29–37.

[45] *Ibid.*

operation in all five "standard" makes, Norton[46] concludes that the usual typewriter falls about two fifths (.4) short of today's highest efficiency. You or some other students may pay a price in energy cost for any school indifference in the selection of typewriters.

Surprising work differences between machines of the same "standard" make evidently demonstrate the real need for a uniform factory adjustment on all school typewriters. In Norton's[47] tests, five typewriters of a single make varied from 57 to 102[48] in type-key resistance alone. The least variation noted in typewriters of identical make was 38 to 48. Even though you merely change to another machine of the same make, you are likely to meet with unforeseen discomfort.

If you attempt shortly to try typewriters of different makes, you will subject yourself at once to new machine interference. The differences between five makes of "standard" typewriters are striking. One has typically a heavy touch, another a light touch, or another lies in between. In the studies made by Trinks and by Norton[49] for L. C. Smith & Corona Typewriters, to operate the machines of a heavy-touch make consumed fully one third more work (134% to 174%) than to operate typewriters of a light-touch make (100%). Such differences are clearly shown in Table XXII. When the total work required for typing an entire business letter is estimated, you are able to sum up, as in Table XXIII, the differences between makes of typewriters. Is your school as curiously prone as numerous other schools to use machines that offer high resistance?

Before you are carried away by favoritism born of familiarity with your trusty practice machine, observe what other makes of typewriters offer. Is there still room for your enthusiasm if you find another machine having a more handsome typescript, a lighter touch, a fuller enclosing of the working parts, a lighter shift, or a sturdier endurance? Choice of a typewriter is too

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[46] Norton, F. H., "The Work Required to Operate Several Makes of Typewriters," *Transactions* (The American Society of Mechanical Engineers, 1927–1928), paper MAN-50-18.

[47] *Ibid.*

[48] Ergs, divided by 10,000.

[49] *Op. cit.*

TABLE XXII

AVERAGE WORK PER STROKE (IN ERGS, DIVIDED BY 10,000) FOR TYPE KEY, SPACE BAR, CAPITAL SHIFT, AND CARRIAGE RETURN, REQUIRED ON 5 L. C. SMITH, 5 REMINGTON, 5 ROYAL, 5 UNDERWOOD, 5 WOODSTOCK TYPEWRITERS (From Norton [50])

Stroke	"Standard" Makes (Unidentified)				
	A	B	C	D	E
Type key	42	48	60	63	76
Space bar	21	44	29	32	23
Capital shift	107	141	98	107	153
Carriage return	1150	1280	1340	1490	1420

TABLE XXIII

COMPARISON OF TOTAL AVERAGE WORK (IN ERGS, DIVIDED BY 10,000,000) REQUIRED TO TYPE AN AVERAGE LETTER ON THE L. C. SMITH, REMINGTON, ROYAL, UNDERWOOD, OR WOODSTOCK TYPEWRITER (From Norton [51])

Operation	"Standard" Makes (Unidentified)				
	A	B	C	D	E
To operate the keys	29.8	33.6	42.4	45.2	53.8
To return the carriage	27.2	32.2	32.4	35.8	34.0
To operate the space bar	2.8	5.2	3.8	3.6	3.0
To shift for capitals	4.8	5.4	3.8	4.2	5.8
To line space	16.8	21.2	17.8	10.8	14.1
Total work	81.4	97.6	100.2	99.6	110.7

complicated for you to be told outright which one of the standard machines seems best suited to you. Yet, all in all, one would seem distinctly better, even though others excel at other points. Very likely the choice of machines used in your typing class is not a reliable guide. Often it has been said that fast typing is a matter of the typist rather than of the typewriter. This is only partly true. Individual likes and dislikes differ so much, however, that class machines ought to be somewhat different.

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[50] *Ibid.*

[51] *Ibid.*

3. *Consumers' study of typewriters.* All the famous makes of modern typewriters are sturdy enough to be still swinging type many years hence. When rebuilt in its factory, even an older machine is completely checked, cleaned, and restored in all parts. Hence if you do practice on an older model, it will pay to inspect your machine for its particular arrangements. Check even the backspacer key. In older models it may have wandered. Check the tabular key. Check the stops and releasing devices. You may want, for example, to release your margins on occasion. Toy even with the variable line spacer. Check the shifts, too. After all, since you plan to make this machine a part of yourself, you will naturally check for a light touch, too. Always check the evenness of each written line of type, since even alignment more readily disappears in some makes of typewriters. Keep your instructor informed of any obvious lapses in your machine's efficiency. Later, when you and this typewriter work as one, your efficiency will be just so much greater.

If your typewriting class is to make an honest study, as a "consumers' research," of various typewriter makes and models, one simple test suggests another. Sit down, for instance, and toy with a type bar. Estimate its distance from the paper. Raise it slowly, but pause every inch or so. Let your finger feel how much it resists. Try to feel how much faster it moves the further it goes up. Take your other hand and move this type bar from side to side. How about its firmness? Press the type bar against the paper. Does it stop dead or is there some life and a cushionlike "give" to it? Watch the speed with which it drops back. Pile up a few keys and see how they release.

In your typing workroom all the different machines are lined in rows ready for such comparisons. In checking key resistance, however, the ordinary pressure gauges can be misleading. Even to test this resistance, or touch, by your regular typing is apt to be misleading. If you are used to a heavy-touch machine, for instance, your comparisons will be poor. You will be unable to use your regular stroking on light-touch machines. Mere repeated, light touching of the keys along the row of classroom machines is a superior test. On rare occasions it might be feasible for a class to suspend test tubes under each key and slowly fill each tube with shot until the type face touches the paper. The relative weights of every tube and its load of shot then demonstrate the varied key resistance of the school typewriters.

These glimpses at gratuitous handicaps may be rather obvious. Press the shift keys and feel the resistance in the pressure feel of some, the lightness of others. Try the carriage throw. How close and accessible is this lever to your left hand? How far must it move before the carriage return actually starts? What does each machine have in the way of tabular keys? Set all stops. Read all scales. Try the variable line spacer by inserting an entire word, differing by a letter in its length, as a correction in a typed line. Place similar typescripts from these various machines side by side and cock a critical eye at appearances. By adding other customary tests, such as the clearness of more than five carbon copies, you begin to build up a pretty clear mental picture of what you are to cope with in a school machine.

4. *Your own typewriter.* Typewriting is sufficiently complicated if you work consistently with one typewriter. Experimenting with other models may advisedly await advanced and surer stages of practice. Thus, the key resistance of the new "noiseless" machines, which imprint by silent "pressure" typing instead of striking with familiar tapping-clicking sounds, disturbs even expert typists until they have become accustomed to the change. Even the "varityper" adds an extraneous element in the possible variety of its type styles and added shifts. If you attempt early manipulation of special mechanical devices upon special business forms, similar undue interference is in the offing. There doubtless are "124 distinct kinds of typing" done in business offices, calling for half as many special typewriter attachments; yet while you are a beginner there are fewer hesitations in only one kind — straight copy. This need not preclude fitting an interesting variety of practical copy to your future typewriting plans. Your motion study of supporting posture, ballistic stroking, and other manipu-

lation, instead of variegated copy forms, simply is the safer accent at the outset. Know this one typewriter!

INTERPRETATIVE SUMMARY

The approach through problem solving is first applied to the actual machine operation. A suitable balanced fit between the machine's action and the typist's motions and posture requires skillful compromises with the limitations in the present typewriters.

Survival of the original keyboard in a patchwork spatial pattern, never arranged to fit the framework and common-word patterns of the written English language, is an outstanding obstruction. This basic handicap intrudes like the wraith of the Flying Dutchman through all efforts to increase speed and lessen errors in typewriting. For right-handed typists, the overload of the left hand is estimated as 47%. The greater share of the typing is assigned to the upper bank of keys. Some 28% of all the typewriting is forced into awkward finger reaches or hurdles. To correct this handicap, the keyboard pattern has been rearranged into a simplified pattern based upon an exact count of the sequence frequencies in written English. Here awkward serial reaches are reduced to some 3%, and the typing is concentrated on the home row and into the faster stroking between fingers of opposite hands. Initial experimental training upon this keyboard assures surprising savings in learning time, fewer errors, and marked speed gains.

In elevating ballistic stroking to its rightful importance, the closely fitted margin of timing between the slight interval required by the machine and the longer interval required by the typist's stroking raises doubts concerning the accuracy of fit of each student's machine.

Insight into the surprising unevenness in amounts of work required to operate different typewriters is won only by a consumers' study of the various makes and models. Frequent interference lies in the uneven resistance of the separate keys, particularly of the outer keys. With rigid type bars on ball bearings or with the "pressure" typing on "noiseless" machines, this unevenness disappears. Astonishing differences in operating resistance, however, typified by the contrast between a light basket shift and a heavy carriage shift, appear between all "standard" makes. Lack of uniform factory adjustment on school typewriters leaves additional, unexpected differences between all machines. In the development of ballistic stroking, lightness of touch from the outset is a serious issue, since later transfers from a heavy touch to the light, staccato touch entail considerable discomfort.

CHAPTER X

DISCOVERIES ABOUT CORRECT MOTIONS

* * *

READING SUGGESTIONS

To the Student Typist: Read this chapter as a detailed explanation of how to make your typing studies successful as motion studies. First, catch the attitude of motion study, pages 240 to 244. Then study what are called variables of your typing motions, pages 250 to 264. Then overview other necessary manipulation in typewriting, pages 265 and 266. This brings you to guided reading references on the Gilbreth motion study, pages 267 to 275. Further manipulation — the carriage throw and paper change — complete your overview, pages 275 to 282.

To the Psychology Student: You now meet directly motion study in shop and office as a brilliant illustration of applied psychology, pages 241 to 244. Can you apply the motion variables to performances other than typing, pages 250 to 265? Note the brief summary of muscular action, page 253. Reading references to motion-study technique are detailed, pages 267 to 275. You might be interested in a passing reference to applied psychology of advertising display, pages 262 to 267; and possibly in a brief description of changes in a total situation to form a gradient, pages 281 and 282.

To the Typing Instructor: Typing studies are elevated to become applied motion studies. This implies planned experiments with typing motions — teaching by class-conference methods and by visualization methods, especially instructor demonstrations and slow-motion films of correct typing motions. More obvious gaps in much typing classwork are briefly stated, pages 245 to 250. To the Gilbreth variables of motions, pages 250 to 265, are added detailed class readings about the Gilbreth technique, pages 267 to 275. The balance of the chapter overviews typewriting as one whole, pages 275 to 277 and 278 to 282. A brief interpretation is added, page 282.

* * *

A SCIENTIFIC TYPING ATTITUDE

1. *Better motions visualized.* Before discoveries about correct motions can be set to work, each discovery should be definite

enough to be visualized. How do you or others set about definitely discovering these flitting motions of typewriting? Like a burst of musical melody in phonograph recording, they are here but are gone immediately. Only a grooved trace on a receiving disk is left of the melody electrically recorded. Only a trace is left of the motion in the typed sheet or on the sensitive plate of the camera.

2. *Gilbreth motion-study notes: student attitudes.* Practical discoveries about correct motions are more apt to follow a scientific attitude of inquiry. This, too, is elusive. What is your attitude to be? Examine student attitudes in the mirror of two typewriting champions. Scan the stenographic report of conversation between speed typists in confidential mood. The first girl can type 160 words in a minute test. While a novice, the second girl has written 114 words per minute for fifteen minutes.

First Champion. I had habit interference my first year of typing.

Second Champion. I had it, too. It was lack of training in the class. I did not realize that there was such a thing as method in small points. I did not realize that typewriting was going to be such an important thing.

First Champion. You don't have much attention unless you get individual attention. You don't get the right methods of operating the machine unless you get individual attention.

Second Champion. It is the idea of most people that typewriting is something that does not have to be taught. You are simply given a typewriter and taught the keyboard.

First Champion. Most girls take it as a temporary thing. They just figure that if it gets them a position and a certain amount of money, it is all right. All my life I wanted to be an expert at something.

Second Champion. They think if they specialize in one thing they will become one-sided or narrow or kind of queer.

3. *A motion-study workshop.* You could read a formal account of the attitude that leads to expertness, to self-reliant discoveries about motions. There is a more interesting way: project yourself into living experiments wherein real people grope for the "one best way" to do work. While it is hardly feasible to transport you bodily into a motion-study laboratory, nothing should prevent your traveling there on the wings of imagination. Then you can feel

yourself a part of some experiment while you read bits from the stenographic report of what was said. You can imagine the batteries of cameras, the bright lighting, the cross-sectioned screens in black and white against which the slightest motion shows and is measured. You can picture the special clocks photographed beside the motions, or the stop watch impressed upon each film and so timing motions to mere fractions of seconds. You can picture tiny controlled lights on the fingers of the typists, so that every move photographs as a path of light. You may even sense the powerful personality of the engineer[1] in charge and feel the loss from the too early death of this practical man who could dream, who was great enough in ideas and in physical bulk to sweep aside difficulties; a very energetic, determined man, yet jolly to be with; a man fascinated by new discoveries about motions, yet eager to show you more clearly each better way. Above all else, whether in imagination the Gilbreth workrooms seem hazy and distant or vividly near, you can catch from the play of incidental conversation the attitudes in action. Just as you listen to a dramatic scene over the radio, so you can reconstruct this action. Doubtless you catch at once co-operative attitudes of searching for better ways to typewrite. By adopting these civilized attitudes you and your classmates and your instructor, literally, can transform your typewriting class.

4. *Gilbreth motion-study notes: what is motion?* These unstaged incidents in the Gilbreth motion studies come to you by stenographic records instead of by radio. The effect is much the same.

Mr. Gilbreth (in a little introductory talk). I believe that what makes a champion is common to all fields. We have found extreme resemblances between the surgeon's motions and those of the bricklayer, the motions of the pianist and those of the typist. We have champion fencers, champion baseball players, champion typists. I have not found enough yet to know just why there is such similarity. Mrs. Gilbreth has been harping on the likeness of the trades. I found a champion at a lathe, and he had peculiar motions. I found he had been a baseball player. We have you here to walk off with your motions.

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[1] Frank B. Gilbreth, 1868–1924.

Mrs. Gilbreth. One of our golfers studies films of his "play" by the hour. He finds that he moves his head, although it was a pet theory that he didn't move the head in golf.

Mr. Gilbreth. I want to find out whether this girl who is a champion knows what she does or not. It is my claim that she does not. I have tried it on everybody and find that my claim is true, and I want to try it on her and see whether it is still true. . . . A habit is supposed to be too intangible to photograph! When I photograph a "greenhorn," the lines in different performances of a "habit" won't coincide by a great deal. If a girl is an expert, and nothing interferes, the lines will be very close together.

Speed Coach. Each finger controls a certain number of keys. The first finger controls six letter keys. The others only control three letter keys. These are vertical rows.

Mr. Gilbreth. I will have to have a picture of that. She cannot help lifting her finger up in the air.

Speed Typist. We have to do that to make the key come back.

Mr. Gilbreth. Yes, that is a habit.

Observer. The middle finger gets back quicker.

Speed Typist. The middle finger is faster because the first finger has twice as many keys to handle.

Mr. Gilbreth. Let us try the other fingers. I want to show you that she can do it much quicker if she holds her finger over the key and comes down. Now she comes up and down. I want her simply to come down. (To girl) I want your finger to be above the key.

Speed Coach. That is too much. We use a distance of a quarter of an inch.

Mr. Gilbreth. I accept the correction.

(*Speed Coach* shows that it is difficult to get the pressure right because of interference with a typewriting habit.)

Observer. The left thumb never works.

Mr. Gilbreth. Because she has been taught that.

Speed Coach. I want you to analyze her wrist action, and see whether it is different from this other typist's. She has her fingers on the top bank. The other girl has her fingers on the second bank.

(Wrist action. Camera turned very fast.)

* * *

Speed Typist. You notice things about yourself that you would never think of. For instance, my elbow seems to travel a mile.

* * *

Mr. Gilbreth. What is a motion? I come here and get my pen. One motion, two motions, or three motions? Where does one leave off and the other begin? You cannot tell where a motion begins and where it leaves off. What shall be the subdivisions? The subdivisions shall be, first, a cycle. There are fifteen cycles in an hour's operation, because you have written and changed paper for fifteen sheets. The motion cycle consists of putting in a piece of paper, writing it, and taking it out. A smaller cycle would be a word. There are certain normal divisions of the cycle. There are at least seventeen. These are "search," "find," "select," "grasp," "transport loaded," "assemble," "let go," "inspect," "transport empty," so on. You may use all of them, or you may not. They may have different sequences. I will take a drill press, which is easier to demonstrate on. I am going to bore a hole in the end of this piece of cast iron. If it is given to me wrong side up, I have to "position" it. If not, I can pick it up this way and it is ready instantly. If the pieces are in standard position, I do not have to send my eye after one. If you send your eye and hand, you are sending two messengers to get one sheet of paper. Here you have "search," "find," "select," "grasp," "transport loaded," "assemble." Then the other hand gets busy when you "position" for the next operation. When this girl's machine caught, she had an "unavoidable delay" in the fingers of one hand.

5. *Working out your own motion study.* How is it possible to overlook a like working out of your own motion study? An expensive study laboratory would be interesting but not necessary. Your typing classroom is simply full of motions, motions on every side and in front of you, motions a part of you. Surrounded by countless typing motions, how can you miss eliminating a few, reducing others? You are not asked to slow yourself by painstaking verbal decisions while typewriting. You are asked to watch motions, relax motions, feel a new smoothness and ease the while you follow words with your typewriter.

Despite the increasing precision of the machine, typewriting remains a hand skill. You, as typist, supply the correct motions. The more all-distracting nonessentials are stripped away, the more clearly typing stands revealed as a supply of correct motions. To furnish these correct motions is more a mental than a manual ability. This implies that you become motion-minded.

NEGLECT OF CORRECT TYPING MOTIONS

The issue seems clear-cut; the practice often is not. Correct motions can be obscure and can stay obscure. They can be buried under a clutter of overaccurate exercises "perfectly" written in slow tempo. Do you, for instance, ever drill mazes of nonsense syllables as exercises? Here is a sample hybrid drill:[2] "Chimaphila Maculata, Corydalis lutea, Corydalis Cheilanthi-folia . . . Eximia, Dicentra Cucullaria, Dodecatheon Meadia, Epimedium, Funkia Minor." The effect is to increase the clutter. At least you do not have a manual with fifty college football yells added, or better yet, the few pages of Einstein's formulas uniting magnetic fields and gravitation, or Esperanto paragraphs as practice material! To multiply your copy troubles in such ways would hardly be planful engineering. Genuine planning is impeded also by a narrow academic approach stressing the per cent perfection of your typewriting. You have only one prime task: to discover correct motions. Your early efforts are of no further consequence except to the wastepaper collector.

1. *Shortage of master typists as instructors.* What does occur to interfere with planning and permit correct motions to be buried under academic requirements? A first obvious cause would be that many instructors themselves are not master typists. A mediocre typist remains a poor source of correct motions. Certainly you will seldom discover correct motions by observing a mediocre performer. It might be disheartening to ascertain just how few typewriting instructors have even a fair net speed of 80 words per minute. Crooks[3] regards 100 words per minute as a truer standard of skilled operation today. Consider yourself warned that only the rare instructor who is not a master typist avoids the pitfall of a mere academic stress upon per cent accuracy of written exercises.

2. *Guesses about correct motions too fast for the unaided eye.* A second obvious cause is the *speed* at which correct motions are

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[2] White, W. T., "Drill to Develop Concentration," *The Rowe Budget* (1931), Vol. XXXIII, p. 11.

[3] Crooks, Maxwell, *Touch Typewriting for Teachers* (Sir Isaac Pitman and Sons, 1931), p. 140.

performed. In the literature of typewriting appear many statements urging you, as a student, to observe experts as an incentive. This is not the most usable point at all. You should observe experts to discover correct motions. Even an expert shows faults, but there is enough likeness between several experts to reveal good form in motions. At this point enters the rub. You are not able to see the expert's demonstration except as an amazing blur of speed. There is a rush of strokes, and the writing is complete. The human eye is inadequate.

There is only one short cut to this demonstration of correct motions. It is the short cut developed by the Gilbreths: extend the human eye by mechanical devices. Most brilliant of these is the slow-motion picture film, with each correct motion and its timing definitely measured by Gilbreth technique. In the showing of such films, the correct motion is slowed in a measured setting until it is clear-cut in your vision. Each fast motion can be slowed in a motion-picture film and still preserve its form. This is untrue of the expert. When the skilled typist attempts to slow each motion, the form is altered. This is inevitable, because mechanical forces in the stroking are altered. This fact has been repeatedly demonstrated with monotonous regularity by cameras in the Gilbreth laboratories. Further devices also aid you to discover correct motions by your own vision. The Gilbreths have attached tiny electric-light bulbs to the fingers and photographed as a line of light the direction, speed, and path of each motion. If essential, wire models can then be made of any motion path.

In the field of typewriting practice, the past enthronement of guesses about correct motions was excusable as long as typing hours were infrequent and the dearly earned skill of a few typists largely a matter of stamina and chance. Today such guessing is an inexcusable daily imposition, since you are one of an army of student typists numbered by the hundred thousand. A misleading guess is a reflection upon large areas of commercial education in the United States. Naturally, the real leaders in commercial education are alert to prevalent and misleading beliefs about typing motions and the inevitable despoiling of the learner's time and skill. Concrete signs of this new alertness are not lacking. Experiments with moving pictures by Harold H. Smith are such a sign. As a result, you may have seen moving-picture illustrations of a champion typist, George L. Hossfield, used to demonstrate correct motions of stroking the keys, reaching for the shift key and making capitals, returning the carriage, inserting and straightening the paper, together with correct positions of body, arms, and hands in actual typing. This is a definite step toward helping you visualize correct motions from the outset. At the same time these helpful illustrations seem less definite and correspondingly naïve by comparison with the refined accuracy of the Gilbreth motion studies. The clearness of an expert demonstration needs to be sharpened by time measurements.

3. *Excessive reliance on typewriting manuals.* A third obvious cause for the neglect of correct motions will arise if you place too much reliance on a textbook. In few other school subjects have the assignments, budgets, and work sheets advanced to such elaborate and finely organized forms. In few other subjects would you receive such a complete course assignment at the outset. This outstanding development of the assignment in your school world, nevertheless, has stressed written exercises at the expense of correct motions. The better typing manuals can still be counted on the fingers of one hand. Others too often become a conglomeration. No amount of printed description can deftly demonstrate a correct motion when you are confused. Many of the manuals tacitly admit this by printing very little about correct motions. At best, verbal directions bring out some aspect of the whole motion through your appreciation of an inspired adjective. Well-known samples of clever adjectives applied to stroking are the "quick getaway" motion from a "red-hot" key,[4] the "staccato," finger-tip motion with a "rubber-ball" rebound,[5] the "snatch" stroke,[6] the "swishing, glancing" flick

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[4] Harned, W. E., *New Typewriting Studies* (Ginn and Company, 1930), p. 12.

[5] Maclean, Lola, *Walton-Maclean Typewriting Procedure and Practice* (Walton Publishing Company, 1931), p. 3.

[6] Lessenberry, D. D. and Jevon, E. A., *20th Century Touch Typewriting* (South-Western Publishing Company, 1927), p. 13.

of a "tiger's paw."[7] Not infrequently general verbal directions confuse rather than clarify your understanding of complete motions. This is an individual and not a general matter. The manual's general collection of adjectives may have missed the aspect essential for your insight. Nor does it answer to have your instructor put you through the correct motions. Despite the glowing encomiums on the "motion feel" in typing, no other sense equals the clarity of a visual check by the eyes. Once your own eyes have seen a motion demonstrated in a slowed film or elsewhere, the correct motion may emerge for you as a clear-cut figure or form. Incorrect motions drop accordingly into unimportant background. All the aspects of the complete motion are present. The complete motion, when slowed without loss of form, lends you essential clues needed to improve your supply of motions. It is at this point that verbal suggestions from an instructor focus these essential aspects.

Perhaps it is uncharitable to insist that this concrete study of actual typing motions on the expert level can be as fascinating as reams of printed description or exercises can be monotonous.

4. *Inadequate control of complicated variables in typewriting classrooms.* A fourth cause for the lack of correct motions arises in the complicated nature of your typewriting behavior. The correct motion depends on all the shifting variables of your individual self, your instructor, your typewriter, and your other surroundings. Correct motions continuously and literally are at the mercy of any disinterest on your part, or poorly planned work, or inadequate manual, or other imperfections of the typewriting class. Usual gaps in equipment have to do with table and chair that fail to fit or support your posture, a typewriter still carrying an awkward keyboard and heavy touch, a lack of slow-motion films to visualize better motions. Interference rather than support from any of these variables may distort or even block the correct motion. Your own alertness and an admirable manual, for instance, may be defeated by an untrained instructor. A clever

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[7] Wiese, E. G. and Coover, J. E., *Kinesthetic Method of Learning Touch Typing* (H. M. Rowe Company, 1927), p. 1.

instructor and a precise machine, for instance, may be unavailing for some shiftless classmate content with sheer disinterest. A slight change in almost any variable of the surroundings may have unexpected practice results. It might be only a cushion added to adjust an uncomfortable chair, or a simple copyholder installed, or eraser dust removed from a machine. The seemingly most trivial interference you may feel as important. It might be any one of so many other variables that any listing would be laborious and incomplete.

Certainly such a list would run beyond the typewriting classroom to meet the social variables of school life, home life, and out-of-school leisure. Typing behavior is part and parcel of your personality adjustment to a world, however limited, in which you are living. Accordingly, the complete situation must change until correct motions do appear. Can you appreciate how you are aided by an instructor who learns to be more sensitive in his adjustment to you? Necessary changes are at once made in your machine and its surroundings. The flaws in your motions are illumined by mechanical or other diagnostic measurements. The kind of motions which you appear to need are demonstrated. More suitable materials are worked up for your daily practice. Then you react to these changes in the instructor's attitude, the more efficient materials, and the improved surroundings by moving in the direction that will adjust you to these changes[8] — the direction, in short, of correct motions.

Do you observe what a complicated undertaking it is to handle so many changes in the typewriting class and to swing them at the right moment into the line of your progress? Doesn't the belief that skill arrives when you fix automatic finger habits by repetition of certain pet exercises become naïve and amusing? And how foolish it appears to leave your supply of motions to chance! All these necessary changes can be simplified. This is done by measuring their results. Each practical change becomes a definite standard when its result is known. There is much in typing, unfortunately, not yet simplified into definite standards. You will recognize available standards, however, by the systematic orderliness that follows in your class. What is systematic orderliness? Probably your readiest answer to this query, in terms of typewriting, would be to check one by one the items of such lists as Blackstone's[9] typing-class summaries. Isn't it a rather surprising and admirable fact that a fully prepared instructor can control enough variables to bring out correct motions?

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[8] Sheffield, A. E., "'Gestalt' and Case Study, I," *Social Forces* (1931), Vol. IX, pp. 465–469, 472–474.

VARIABLES OF CORRECT TYPING MOTIONS

Perhaps in the typing class you enter for the first time a workroom wherein your ordinary work can be trebled by firsthand study of your own output. This class may be the closest approach in your school to the "scientific management" with which the Gilbreths and other engineers have so greatly changed shops and business offices. Here your typing studies pursue complete motion cycles. Each cycle is performed as one whole — from your first reach for a fresh sheet of paper to its final twirl as a finished typescript out of the machine. Yet for convenience the parts of each cycle are listed by such terms[10] as *play for position*, *use*, or *unavoidable delay*. For the moment you also see your typing as parts of motions and trim away each needless part.

In order that you may easily and rapidly learn to typewrite through motion and time study, the Gilbreths give you seventeen names to identify these parts, or steps, in your motion cycles. As you start the day's practice, for example, your left hand may (1) *search* for your supply of paper, (2) *find* the paper, (3) *select* the top two sheets, (4) *grasp* this paper with thumb and finger, (5) *transport* this paper load to your machine, (6) *position* the paper under the roller, and (7) *release* the paper load while your right hand (8) *uses* or twirls the cylinder knob. You now bring your eyes to (9) *inspect* the evenness of the paper. Your left hand (10) hastens to drop (*transport empty*) back to the keyboard. Here are ten motion steps. If carbons had been called for, you would also have had to (11) *assemble* the carbons between the sheets, and at the end of the cycle (12) *disassemble* the carbons from the typed sheets. Now there are a dozen motion parts to improve. There are several other steps which you need. In typing *you*, for example, there is just enough pause to (13) *plan* your stroke to the *y* key. As this finger strokes, you (14) *preposition* your next fingers for *o* and *u* strokes. Between these overlapping strokes there is slight, (15) *unavoidable delay*, but any obvious hesitation is a sign of (16) *avoidable delay*, while errors may also be a signal for a brief (17) *rest.*

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[9] Blackstone, E. G., "The Supervision of Commercial Education," *The Supervision of Secondary Subjects*, W. L. Uhl, Editor (D. Appleton-Century Company, Inc., 1929), Items to Observe in Typewriting, pp. 383–384; Devices for Typewriting, pp. 368–369; Selby Score Card for Commerce Departments, III. Typewriting Room, pp. 372–373, with Check Lists, pp. 375–376; General Items and Types of Teaching Errors, pp. 359–360, 379–380.

[10] Gilbreth, F. B., *Motion Study*, "Variables of the Motion" (D. Van Nostrand Company, 1911), Chapter IV, pp. 65–85.

These simple terms bring increased definiteness and facility to your observation of motions. Apply such a simple idea as *play for position* to your study. Typing includes at least two combined key strokes. The isolated letter stroke is dropped for the same reason that the slow key stroke is dropped. Neither can be utilized in successful typewriting. In two-letter combinations the *play for position* becomes a highly significant detail. In other words, a second finger jockeys for position as a first finger depresses its key. As the latter rebounds, the second finger has already started down to its unavoidable pause (only long enough to launch the mechanism) on its own key. Meanwhile the first finger is again hovering in position for its next move. By this overlapping the succession of your key strokes is fused into one complete *sequence.* Typing is broken into such convenient parts only to locate and correct some inefficient detail. The defect might be too slow a *play for position*, an *avoidable delay* en route, or other flaw which you promptly *inspect* by your senses. This might mean inspection by "feel" (such as from motions of muscles and joints or from touch of finger tips), by ear (such as even "clicking"), by eye (such as evenness of imprinting on the paper or study of the slowed motion in a film). In all such typing study, you attend to what are called the *variables* of correct motions.

1. *Is your motion necessary?* The variables of motions overlap widely, since each presents merely a single aspect of the whole correct motion.

There are variables such as the *necessity*[11] of certain motions, the relative balance between *tension* and *relaxation*, the *energy cost* and the *feeling cost.* The contrast between "necessary" and "unnecessary" motions is perhaps the most striking feature in your study. Probably there is no more potent "magic" in typing improvement than a ruthless cutting out of needless motions until the fewest possible remain. You are to simplify the action. Yet, despite clever analogies and the easy naturalness of correct motions, doubtless you have already waged a struggle to hold virtually your whole body back from movements in keeping with the typewriter. The humorous thing is that relaxing is the exact opposite of a struggle. You just let go. Have you glanced yet at the flopping hands, wrists, and elbows of fellow beginners? For a time your whole hand may have also tried to rebound with each stroke, let alone the useless motions you made with forearm, upper arm, and even shoulders.

Thus Smith[12] warns that flopping hands and wrists are accursed; that you draw power from the arm without motions above the wrist, from the vaulted hand without motions while each finger reaches and strikes as a single motion; that even required hand vibration is relaxed after each finger stroke. Gradually you reach the keys with less and less forward and backward or sideward in-and-out movements of the arm. Slowly your crude hand motions disappear. Slowly the newly conditioned finger motions appear. A fine finger action appears so foreign at the start that Smith[13] tolerates for a while a down motion and low lift of the hand from the wrist much like the "walking beam of a steamboat." You seek to free yourself from any further struggle such as you may already have waged to free each finger of needless motions by companion fingers. This restraint may have reached its height as you dropped unnecessary motions by the fourth and second fingers whenever the third finger stroked. Naturally, all fingers should move in direct curves, each from its own knuckles — the middle knuckle loosely above a "guide" key. Notice, too, that the row of joints between fingers and hand is a hinge for your loose fingers. Of course each finger is always well arched. Gradually your arched fingers start from natural, well-curved postures and the stroking becomes mainly opening and closing the fingers.

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[11] Gilbreth, F. B., *op. cit.*

[12] Smith, H. H. and Wiese, E. G., *Seven Speed Secrets of Expert Typing* (Gregg Publishing Company, 1921), pp. 15–19.

[13] *Ibid.*

Do you now realize that before you drop unnecessary motions you must set a posture to support what slight motions remain? To cut down finger pressure, of course, you need your wrist and arm. Examine forearm and hand as one continuous line and try to imagine the forearm muscles extending through tendons out to the fingers. See that this straight line has the slant of the keyboard. For this, your elbow tip (or funny bone) simply has to be below the keyboard. Up this slant, and across quiet wrists, just firm enough, rapidly comes sufficient power from your forearm to your arched fingers. Each wrist pivot helps you balance the least energy and weight in the flying fingers. Keep the back of your hand up so that it carries most of each finger's weight.

At this point a good waste motion sample contributed by Smith[14] is the needless swivel movement if the hand is trained to swing from the outer *a* and *;* as your sole "guide" keys or from similar "anchors." So long as the hand is directly in line with the arm (with no awkward angle at the wrist), you stroke straight ahead as a clever typist. An analogy is to walk erect so that you do not "toe out." Yet do not permit yourself to feel alarmed when you fall short of pure finger motion, since the motion pictures of experts reveal free and well-poised movement of the hands.[15] What you seek is partial relaxation rather than restraint. The more you let go useless motions, the more every remaining movement may seem to you entirely necessary. Confidentially, the Gilbreths[16] would even now view many of your remaining motions as intruders. You would agree if you could see yourself type in a slow-motion film!

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[14] *Ibid.*

[15] SoRelle, R. P. and Smith, H. H., *Gregg Typing Techniques and Projects* (Gregg Publishing Company, 1931), p. 8.

[16] Gilbreth, F. B., *op. cit.*

2. *Tension and relaxation.*[17] How can you help but admire, as you progress, the increasing symmetrical smoothness of each complete word sequence due to the central control of its pattern? Really, this dropping out of unnecessary motions is also relaxation. Just as the tension in unnecessary movements is relaxed away, so the tension in needed muscles is relaxed to the least possible amounts for holding the position and rapidly working the machine. Yet you have already learned to recognize the beginning typist who goes tense from head to toe.

Time is taken out by Crooks[18] to chide not only rigid arms, but also a stiff back pressed against the chair or feet braced on the floor. This typing authority suggests a simple but clever experiment to demonstrate the excess tension at the bottom of aching fingers. You recall how the muscles of each finger work in teams, so that movement by the one can be counterbalanced by the other. As one set of muscles strokes the finger, the other counteracts. Unnecessary counteraction must be relaxed. It is suggested that you press your finger on the table to discover this counteracting tenseness from the "under" muscles. Then press the table in a way not to feel it. Next tap the table alternately with and without the use of the unnecessary "under" tension. Next stroke the keys of the home row in the same way, with and without the needless tension. Do you still feel these regular patterns of thickening and thinning in your finger muscles? Doubtless you recall the equally simple demonstration that fast stroking is chiefly the rebound from the key. Almost no tension is left in finger muscles propelling a fast *ballistic* stroke. Once thrown, a finger flies relaxed. Momentum and weight of the finger depress the key.[19]

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[17] See "Practicing Control of Typewriting," Part Two, Chapter V, pp. 81–101; or Jacobson, Edmund, *Progressive Relaxation* (University of Chicago Press, 1929), pp. 84–96.

[18] Crooks, Maxwell, *Touch Typewriting for Teachers* (Sir Isaac Pitman and Sons, 1931), pp. 75–77.

[19] Review the discussion of ballistic stroking, Part Two, pp. 147–149; or read Hartson, L. D., "Analysis of Skilled Movements," *Personnel Journal* (1932), Vol. XI, pp. 28–43.

Without this relaxation following tension, rhythm would not appear. Almost at once the opposing muscles catch hold for a rebound. A smartly smooth getaway is in like manner an unfelt triumph in relaxation as the finger returns. The moment you learn to apply partial relaxation, you will vastly prefer resting before the typewriter, with arms and wrists and hands loosely limp, to the fighting attack of the unwarned beginner. Crooks[20] hints that the teacher's call to position might well be followed by the command, "Now relax completely." Typewriting is a relaxed following of copy sequences with your typewriter.

3. *Limits of expert speeds.* The value of fewest possible motions and least possible tensions is vividly enhanced when you consider the future limits of expert speeds. As typing rates rise, fresh speed gains are increasingly difficult. Why? Resistance from keys and gravity as each finger weight rebounds is hardly enough for this. Internal resistance increases in the shortening muscles themselves. The rise of this internal resistance, as pictured by Fenn,[21] uses more and more energy. Essential chemical energy comes probably from the breakdown in muscle of a substance called "phosphocreatine." This chemical energy is transformed into mechanical key stroking with at least 50% efficiency. Yet as the speed of flying fingers increases, the muscles must shorten more rapidly to maintain their pulls. There is not only less time to develop new chemical energy, but the faster shortening also heightens frictions from the action within the muscles. The faster the muscles shorten, the less tension can be exerted. At a shortening rate of 10% of its length per second, a muscle loses some 3% of its tension. Just what muscular tensions are increasingly lost in faster stroking? As the striking finger gains high velocity, the downstroking muscles relax in teamwork with opposite "under" muscles. These opposed muscles start to catch and check the finger sooner than you realize. At the instant the finger stops moving in its pause upon the key, these opposed muscles develop tension for the rebound. As the limits

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[20] *Op. cit.*

[21] Fenn, W. O., "A Cinematographic Study of Sprinters," *The Scientific Monthly* (1931), Vol. XXXII, pp. 346–354.

of speed near, these muscles can no longer exert this tension. The finger falters. Aided by most expert partial relaxation, every last fraction of a second is clearly needed for the fastest typing.

4. *Energy cost and feeling cost.*[22] This reason for fewest possible motions and least possible tensions reappears in the similar variables of *energy cost* and *feeling cost.* The least possible amount of foot-pounds of work done per typing assignment, with all else equal, as the Gilbreths[23] tell you, means the least loss of working time in rest to overcome fatigue. You have just read how correct, fast motions take an increasing toll of energy cost from you. There is added fatigue, such as of the eyes from reading copy, of the ears from the noise of a typing class. Be careful that the toll is not increased by unnecessary motions. Even correct motions overlong continued grow monotonous and boresome. This is the feeling cost of work. Be careful that this loss of interest is not enhanced by pressure of other work ahead, by outside worries, or in other ways. Upsets in the first speed typing tests are a common illustration. With excessive energy costs and feeling costs, correct motions suffer the varied interference called *fatigue.* This is offset by a change of task or by rest, not by slowed typing.

5. *Speed, acceleration, momentum.* There are variables such as *speed* of motions, *acceleration,* and *momentum.* Next to fewest motions, speed seems the most potent influence[24] in your coming high output of net words per minute. You gain definite advantages by fast ballistic motions, apart from more output in less time. Among these are increases in momentum, acceleration, and closer overlapping of motions.[25] Of course a faster momentum works both ways. It is harder to stop, just as the inertia from any delay makes starting harder. For this reason correct motions contain as few starts and stops as possible.[26] Even the pause in the midst of each key stroke is highly compensated by relaxing the downstroke and hastening the rebound. Think of speed as

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[22] See pp. 400–422.

[23] Gilbreth, F. B., *Motion Study, op. cit.*

[24] *Ibid.*

[25] *Ibid.*

[26] Gilbreth, F. B. and Gilbreth, L. M., *Applied Motion Study* (The Macmillan Company, 1919), pp. 110–111.

this accelerated rebound from each key. Probably it is your getaway that falters as you approach your present speed limits. In this manner note that speed improves partial relaxation and lessens tension, or vice versa. Accelerated momentum can be nicely illustrated in the improved type bar as it comes up. Accelerated finger momentum likewise carries the stroking along, so that relaxing is easier for you. Even the unavoidable waits by certain fingers are partly compensated by hovering lightly just over the keys rather than resting. As skill in handling familiar words grows, the strokes come closer together. Increase of typing rate should be the result of decreasing intervals between rapidly executed strokes. At high speed there is a definite overlapping of strokes. This increased overlapping between strokes and prompter plays for finger positions actually catch up much of this slack in starts and stops. The closer overlapping also improves the conditioning or accuracy. Speed also helps to hold the rhythm. This is quickly felt in the slowing for difficult words and acceleration over familiar words. Yet your speeding finger tensions can still be carried along through the difficult fingering. The faster speeds thus support a swinging line rhythm as long as a sheet of paper lasts. These advantages which accrue with fast motions are impossible with slow motions.

6. *Direction, path, length of typing motion.* The differences between fast and slow motions reappear in such variables as the *direction, path,* and *length* of each motion. A slow motion necessarily follows a different path.[27] Although lightly curved, the path of a fast motion is more nearly a line of quickest speed. Such a path lends you a high saving. If possible, its desirable direction also uses the aid of gravity, as in the downstroke that depresses the key. Any motion path should be the shortest distance consistent with a loose, *ballistic* sweep, utilizing momentum and gravity. Measure the distances between your hand and the carriage-return lever, between your fingers over guide keys and their number keys, and between your little finger and the tabular key to illustrate this. The elimination of the un-

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[27] Gilbreth, F. B., *Motion Study, op. cit.*

necessary distances hands and fingers travel, Gilbreth[28] suggests, will eliminate miles of motions per typing class.

7. *Sequence and play for position.* Good typing form depends intimately upon such variables as *sequence* and *play for position.* When you combine two motions in sequence, often you have only one efficient motion left. You simplify your action by transforming several motions into one. Many typing motions in succession are transformed likewise into compact sequences. This is how staccato blows in series can lend a legato effect. In fact, such serial action is exactly what typing is. You are studying sequence. Your typing motions are correctly made *in whatever way best fits them together.*[29] Every such preparation to fit one motion into another is termed *play for position.* By your successive plays for position your strokes blend with smooth facility. Gilbreth's[30] simile is the billiard expert who always plays into position for the following shot or likely loses his run. If you have never seen billiards, ask someone who has; for the illustration is extremely apt.

8. *Automatic conditioning.*[31] The advance of *automatic conditioning* accompanies your typing practice as another variable. It is popularly described as increasing accuracy. Be warned that the conditioning signals exist mostly in tensions within yourself. Of these signals you may continue to be quite unaware. Yet if you are able to hold the correct position in relation to the inclined plane of the keyboard, left hand balanced by right, and then practice correct motions at regular rates, the conditioning will be of great assistance. More and more motions will have an automatic ease, freeing you to improve other motions. If you fail to hold this position, if you drill upon motions incorrectly made, if your pace is irregular, if your typewriter and your materials and other class surroundings are old-fashioned or ill-fashioned, then the conditioning becomes a real detriment.

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[28] Gilbreth, F. B., *Motion Study, op. cit.*

[29] *Ibid.*

[30] *Ibid.*

[31] See "Automatic Conditioning to Typing Signals," Part Two, Chapter VI, pp. 102–135.

9. *Fixed outcomes.*[32] Motion study is the planning of your motions to get certain results more quickly and easily. The needed motions are visualized by instruction films, instruction charts, instruction sheets, class demonstrations, and your self-study in order to reach standard results. Correct motions persist and gain stability by virtue of this variable. Their effectiveness consists in producing the desired result. This implies that you desire to complete each typing task and find motions so finely co-ordinated with your total behavior, built up by previous practice and experience, as to bring you to the desired result.

10. *Differing manipulation.* Variables of different but necessary motions may interfere seriously with your early stroking and its conditioning. Any such unlike motions, Crooks[33] fears, may be a handicap until you have mastered the keyboard locations and are stroking about 24 words a minute. Various different strokes, however, such as to a shift key and space bar, are part of any total typing pattern. Such strokes naturally enter from the first days into every typing cycle from a sheet's insertion to its removal.

(*a*) Shift-key Stroking. The shift-key stroke qualifies as an unlike motion that early interferes with word stroking. It varies in the longer time that the little finger must cling to this key. Yet why not inject it from the start, as a fast motion with enough pause to prepare it?

What do you already find about shift keys? Have you a light shift, sometimes jocularly compared to "free wheeling" or pictured as "shift freedom"? Have you a heavier shift that lifts the balanced inner carriage, sometimes called ironically a "dancing" carriage? In either case, of course, you use the left key to shift the right half of the keyboard into upper-case letters, or capitals. To shift the remaining left half of the keyboard, you have the right key. The simplest motion study leads you to approve this faster use of opposite hands together.

Are you going to waste a movement of your whole hand in order to shift? Or can you hold all fingers except the little fourth finger over home keys? Send this finger into a *ballistic* (loose and circular) movement. It should pivot only at its joint with the backhand. It spreads, well arched, to the side and down, so that it strikes the shift between its finger end and the first joint. Let this little finger pivot freely. Let its momentum help. Stiffness is fatal. Going down or up, you simply cannot afford to hesitate, for the shift at best may eat up the time of two or three fast letter strokes. If you are slow, indeed, some capital may blur or topple off the line. Any slowing up should become so slight that it is not noticed. Really you strike the shift just a tiny fraction of a second before you strike the capital letter. Yet both fingers seem to strike together — into fast getaways.

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[32] See pp. 187–191.

[33] Crooks, Maxwell, *op. cit.*, pp. 118–122.

In your motion study of this stroke compare separate descriptions.[34] Let Crooks[35] picture this stroke as a swift sliding of forearm, hand, and fingers as one whole, backwards and sideways, until the little finger just arrives. Then a swift temporary tensing of the fourth-finger muscles, supported by the weight of the descent, depresses the shift key. Let Smith[36] limit the motion largely, if not entirely, to the fourth finger, excepting a partial hand swivel with small hands. Find some clever way to shorten your little finger's circular sweep while you steady your hand. Possible flaws in this subcycle have been summarized as hesitation in finding, raising or dropping of the wrist, unnecessary loss of hand position, too slight a depression or too rapid release of the shift key, incorrect timing of the letter stroke, awkward, slow return to home position, and hesitation in finding the next letter stroke.[37]

(*b*) Space-bar Stroking. The space bar is one of the happy incidents in motion study due to your thumb. Even a fair typist can strike this bar five times to every four times on letter keys. Can you? Hence it is easily caught up in the rhythm of word stroking.

Apply motion study, however, to keep both thumbs active. When you end a word with a right finger, it leaves a foolish waste to wait for the right thumb. Does your left thumb go into action instead? Either thumb strikes with its side. The easiest way is to start the thumb and let it travel relaxed in a sort of loose, circular motion. Do you ever twirl a loosely bent thumb in a circle to try this out? Study a minor distinction. A left thumb usually travels toward the right on the under side of its circular motion. A right thumb usually travels toward the left. All this seems to hold a thumb in a better position close to its index finger and to lend a thumb a better ballistic sweep to the bar. Before you decide, try starting each thumb in an exactly opposite way. With either way, to hesitate may leave two or three spaces — you might even skid a whole line.

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[34] See also Smith, H. H., "The Teaching of Typewriting," *American Shorthand Teacher* (1930), Vol. X, pp. 171–172, 312.

[35] *Op. cit.*, pp. 19–20.

[36] Smith, H. H. and Wiese, E. G., *op. cit.*

[37] Crooks,. *op. cit.*

(*c*) Tabular Stroking. In order to reduce your typing to least time and effort, let the machine do many things which otherwise you would have to do. A tabulator saves you many seconds — which can climb into hours — by automatic covering and counting of white space. A single estimate of spaces on a line is all that you need before applying motion study to your fast setting of stops along the usual rack with its scale. Snap the carriage to each location, read its pointer, set the stop. Work any machine aids, such as a tilting paper table, into this fast motion. Fast typing of outlines is a romp with the tabular key. Already you indent paragraphs perhaps five spaces. For inner indentions for smaller and smaller subheads, you keep setting tabular stops at equal spaces. Instead of typing along lines of details that would easily confuse the reader, use tabular strokes and white space.

When you start to type statistics, your flashes of speed disappear while you pause and plan spacing details. Yet your reward is clear-cut. The typewriter is a famous aid in setting out definite facts and detailed figures to appear simple and clear. When so many figures are typed in even rows, the human mind can begin to grasp them. Before you type columns of figures, of course, you set the stops to catch the foremost figure in each column. With an inbuilt tabulator of five or six keys, naturally you can set a decimal point and reach any desired space before it with one stroke (and no backspacing). The least possible action appears in a statistical typewriter where you start the work and throw in stops as you go with a slight pressure on a left lever, finally releasing all stops with a right lever. When a clear label is typed exactly over each even column, your reader can easily tell what it is all about. Your concise table is better than a long discussion. All your trials and troubles will have made it possible for the reader to see any interesting facts at a glance. Without this carefully planned typing, your reader would be confused. For you to take time now for the orderly details of counting spaces and centerings, however, would be tiresome. To discover them from your own copying of model tables will be somewhat more dramatic.

Once you have set a stop, study to cut down both reach and return for each single "touch" stroke to follow. Pressing down the center of the tabular key firmly with the right little finger carries the carriage flying to the new point on the line. Hold this stroke until you hear the click of a light collision. To the keys of a decimal tabulator the nearest fingers naturally travel in the direction taken for numbers.

(*d*) Attractive Typescripts. Motions that have to do with centering, with shifts of the carriage pointer along the line scale, with setting tabular and margin stops, and with use of line spacers — all aid arrangement of the typing in a balance that is both vertical and horizontal. The typing thus achieves a balance, up and down and across. Your motions thus execute a layout already planned. The need for a prior, attractive design in your typescript is allied to the study of such motions. Yet an artistic arrangement will be partly due to your own feeling and taste.

The demands of motion study prevent your present diversion into a psychology of artistic arrangement. It is a fact, however, that typed pages can reflect the simplicity of modern art in a machine age. There is lightness and evenness to be felt in typed lines and white space instead of solid, cramped masses of uneven, crowded typing. There is a fine regularity to be felt in the march of light blocks of typing — your paragraphs — down the page. A reader can feel clear-cut workmanship, the even rhythm, the careful details with good inks, the full spacing on attractive paper. Such typing is legible, fitted for use. It needs no showy flourish or pretty adornment. Its open display is in the direction of modern art, precision, and efficiency.

Not infrequently a more attractive display for your typed page merits a little planning with a pencil. Into the outline of four straight lines that mark the size and shape of the white paper all that you type should fit. A felt harmony results when these typed lines all seem to belong together. As you type several lines and then with the line spacer separate this block of typing by extra white space, can you feel the size and shape of this block? Can you feel its contrast with white space? If all such space and all such blocks balance, then the result is restful and satisfying to the reader.

There is a simple trick in finding this balance. To have real balance, your page must have a center. Estimate what is called the "optical" center. This refers to eyes. The eyes see the center of the sheet as being slightly above the real center. This is the way both you and the reader see it. Think of an imaginary vertical line down the middle of your paper, dividing your sheet into equal halves. All that is on the right needs to balance all that is on the left. On either side white space and blocks of typing need to be similar in size and shape. Compare all the typing on one side with all the typing on the other, to see whether your blocks are also at similar distances from the center. Then all will attract the reader equally to everything on the sheet. As you consider its form, however, remember that this imaginary middle line — if you prefer the technical term, this *symmetry* — is after all a trick. What you and the reader want to feel more than symmetry is regularity. Often both will be identical.

As you trim the sizes of your blocks of typing, keep in mind the rule of the "Golden Mean." Parsons[38] gives it this way, "Two areas or lines are varied and consistent together, therefore interesting and satisfying, when one of them is between one half and two thirds the area or length of the other."

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[38] Parsons, F. A., *The Art Appeal in Display Advertising* (Harper and Brothers, 1921), p. 43.

If you can make one block of typing, such as a paragraph, between one half and two thirds the size of another block, do so to add interest. Each block of typing expresses an idea. The way to keep these ideas separate is by white space. Try to keep this white space at least one third of the amount of typing, but not more than one half of it. This, too, adds interest.

Bring margins to your aid. Try for yourself a brief appreciation study of white borders. Although left and right margins need to be equal, top and bottom margins are only approximately so. It looks better to hold a bottom border wider than a top margin, so that your typing rests upon a cushion of white space. The spacing at side, top, and bottom is sometimes left in amounts of 5 to 7 to 9.[39] Such differences are not large. In your practical rush all margins are more equal than different.

If you arrange a somewhat mixed page of typing, say a poster, suppose you anticipate less typing on one side than on the opposite side. There are two ways to keep in balance. One way is to add white space for emphasis and keep the smaller blocks of typing further out from the center. A second way is to make the smaller block "different." Thus, if you underscore it or use all capitals, this special emphasis will add enough contrast to balance even a larger block opposite.

Doesn't this suggest another useful trick to bring out an idea with the typewriter? When ideas change or summary time arrives or too many plain lines would seem tiresome, upset the balance of the page a little. Try extra white space, a best position just above the center, a hanging paragraph indention, or a heading or subheads. Like flags upon a golf course, the heading topped by extra white space waves above the copy. Such emphasis carries the reader to the important parts, while the rest of your copy is kept evenly balanced. Such study is already summed up in Sherbow's well-thumbed little book, *Making Type Work*.[40] Emphasis, however, works both ways. Consider how a ragged edge at the right will distract the reader with a wrong emphasis. Carry your lines out. Set your right margin several spaces beyond the planned edge. Divide this or that overlong word, but very rapidly, since your left carriage throw is already on the way.

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[39] Wood, E. H., "Personality Letters," *The Gregg Writer* (1932), Vol. XXXIV, pp. 456–458.

[40] Sherbow, Benjamin, *Making Type Work* (D. Appleton-Century Company, Inc., 1916).

(*e*) Other Manipulation. The aim of this review is to recall that typing fingers move forward along a chain of different motions in one cycle. In a way you do not center paper, hold this tabular key, thumb that space bar, or throw that carriage — instead, you typewrite. All these separate motions are lost in the total typing. Yet to be weak in any part injures your whole typing score. To this end, you make each motion so familiar that it marches evenly in the whole parade of your typing.

Study ways, for example, to avoid using the backspacer — a handy device for centering, underscoring words, inserting omitted letters. It is a sad fact that one complete backspacer motion is all too likely to use up the time of several of your usual key strokes. If you have a special double scale, such as a "red" line scale, you need not use this key for centering. Obviously in typing tests it is best to let sleeping errors lie and not return to them with the backspacer. In stacking up figures, a decimal tabulator takes its place. Time can be saved even by holding down both space bar and shift while the opposite hand strokes an *!*.

For further illustration, if you take full advantage of your machine, you will by touch alone lock parts usually free to move or release movements usually set. Of the former sort, your fingers set a shift lock when three or more strokes type in capitals. Of the latter sort, note that there are moments when you must find a release from the set distance between lines. With a variable line spacer you easily type on ruled lines or anywhere between or fill designs. Study to simplify such pushing in and hooking, pulling out and slightly turning, or slightly squeezing motions. Possibly you merely turn a fractional spacer like a radio dial. There are moments when you must find a release from the set progress of the carriage. Try this release by holding down the period and freely pulling the carriage back and forth to blacken a straight line, much as you would hold down the ' and turn the platen for a vertical line. There are moments in unusually long lines when you need to use whatever key or lever releases a margin stop.

Any manipulation on the typewriter can be improved by motion study. Changing the ribbon will lend a simple yet pretty experiment in motion study. Can you decide upon some seven separate steps in this movement? Can you shortly make this complete ribbon change, including removal of the old spool, in one minute? Even the humble motions of cleaning and oiling gain surprising speed and precision when someone holds a stop watch and you follow a check list of steps. It is much easier to groom your trusty machine by scheduled routine.

Time formerly thrown away in monotonous recopying is now saved by duplicating as many copies as are needed from the one typing. Here are added motion studies. All such duplicating clashes somewhat with the light, staccato touch of fast typewriting. Your even touch must be firmer or heavier for various carbons and stencils. You might find a novel interest in your motion study of inserting ribbons between paper and attaching a copywriter or recordograph to the carriage of your machine. This attachment, by substituting continuous ribbons for carbon paper, presents you with several original copies at once. For more than a few copies, however, you type a master sheet, using a ribbon inked with aniline dyes or special carbon paper. Then you go to a duplicator machine with its carriage and fifteen-foot gelatin rolls. Try for the "feel" of its operation and list more than a score of detailed motion steps. A handy service manual with any machine duplicator helps you plan such definite motion steps. If 100 or more copies are wanted, you clean type faces, move the ribbon into neutral position, and cut a stencil for the inked cylinder of the duplicator. Or you might even use a separate yet familiar keyboard to perforate a curious roll that will remind you of the old player pianos. While this roll unwinds on an automatic typewriter, electric power sweeps the copying along at more than 100 words a minute. Once you are smoothly operating some duplicator, you can be in demand for copies of school and college songs, maps, typed tests, drawings for any class from art to science or shop, even charts of football plays or tryout parts for sock and buskin theatricals.

11. *Gilbreth motion-study notes: typewriting cycles.* By way of variety and a brief summary, catch again a bird's-eye view of the total motion cycle from paper insertion to paper removal by a few brief excerpts from the running record of the Gilbreth studies.

(*Third Speed Typist* is changing paper.)

Speed Coach. She draws her carriage back, and at the same time throws out the paper. My way is practically two motions.

Mr. Gilbreth. That is the best changing paper I have seen. The girl is slow, but she wants to practice. One hand waits for the other. There is no excuse for it.

Observer. She has one paper out when the other is halfway up. Perhaps she could do both together.

Speed Coach. She looks for the paper, and so misses the distance.

Mr. Gilbreth. I said before, one hand waited for the other. Now I think she ought to dive for her paper, and not wait for the other hand. She should bend all energies on the piece of paper that is going up.

Speed Coach. It is, I think, unnecessary for her to look at either. Her eyes should be fixed on her copy. She knows where the paper is.

Mr. Gilbreth. I am going to disagree. She has her eyes off copy when she takes the paper in.

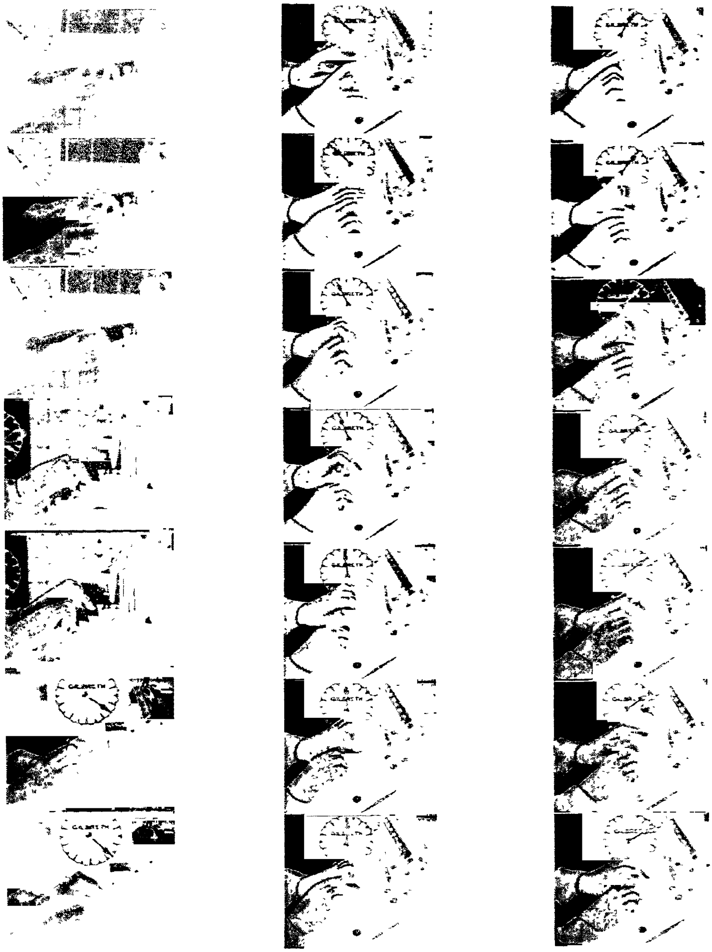
APPLYING GILBRETH TECHNIQUE TO YOUR TYPING

1. *Micromotion films.* What is motion study all about? Why all this bother about films, cameras, and graduated time clocks? Hitherto a typing class has often advanced to timing the stroking rates of its student typists with a stop watch. Has this stop watch proved a valuable check on the very rates that reveal gains in various strokes for various forms of copy? Indeed, yes; time study by stop watch is distinctly superior to cruder attempts at observing typewriting. A stop watch is indispensable in your typing class. Yet by comparison with the slowed motion picture, its time clocks (microchronometers), its cross-sectioned screens, and the camera studies of motion paths, the stop watch alone is already an obsolete tool for motion study.

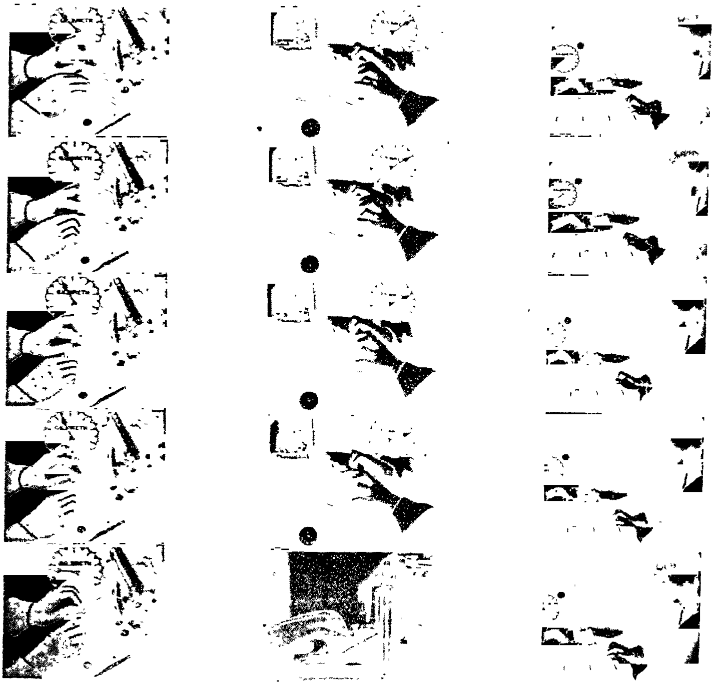
Your first motion-study steps are simple. You should be enabled to view a slow-motion picture of expert typewriting. Only in films can fast typing motions be slowed sufficiently for your study and still preserve their correct form. Any attempt by an expert to show you fast motions in slow time is like asking you to notice "How fast it gets slow!" Whenever you view a slow-motion picture of typing, you have a definite task. You are interested in a definite kind of motion. You watch for this motion. You take note of its clock times. It is the presence of a stop watch right in the film that lends so much definiteness. You watch for the moment when the performance of this motion is at its best. Perhaps this moment never arrives. Then you take a bit from its performance here and a bit from its performance there, in order to build a better motion. At last you visualize some mark about the motion to shoot at. These possible improvements are tried out by yourself or your class or your typing teacher. You may have planned a better kind of motion, and this fact is now demonstrated. It is only a matter of time and less expensive film before similar motion pictures are taken of such typing classes as yours, in order to see clearly the supply of motions present and to discover how this supply can be improved.

Even from mere snatches of film, as in Figures 7 to 9, the variables of correct typing motions emerge in clearer form. Do you catch the relaxation, for example, in the fingers raised above the hand? Look down the first film strip until just below the microclock you see the second finger raised yet nicely relaxed. Likewise as you glance down the second strip notice the smooth ease evident in these finger positions. Take necessity of motions as a variable. Just below the center of the second strip, notice the economy of the thumb position. Even in this glimpse of film, you begin to appreciate that it is the presence of the time clock that adds to this definiteness. Again, in Figure 10 note the fine vaulted arches of the fingers in partly relaxed stroking. Perhaps you, too, feel the smooth, legato movement in the hand (see the bottom of the strip in Figure 11).

To launch your own motion study, there are two brief and clear-cut books for your classroom library — Mogensen's *Common Sense*



Figures 7 to 9. Micromotion Film Strips of Expert Typing, Illustrative of Pla for Position, Overlapping, and Partial Relaxation (From Gilbreth)



Figures 10 to 12. Micromotion Film Strips of Expert Typing with Microchronometer and Screen (From Gilbreth)

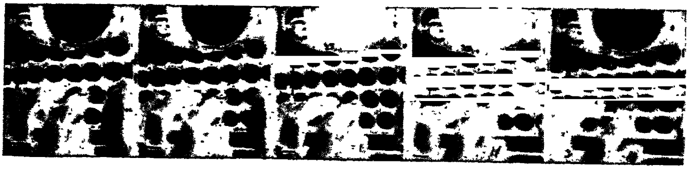


Figure 13. Close-up of Left Second Finger Stroking (From Gilbreth)

Applied to Motion and Time Study[41] and the Gilbreths' *Motion Study for the Handicapped.*[42] The one tells you what typing motion study is all about. The other lends you certain definite details.

The Gilbreths' story of what can be done by blind or crippled typists hints at still greater resources in yourself, untripped by such handicaps. Their little volume starts with the "magic" of motion study. Almost at once you see Margaret B. Owen against a cross-sectioned background that throws her motions into relief for measurement.[43] The likeness of a one-armed typist also shows this feature clearly.[44] There is, too, a glimpse of the Gilbreth workrooms.[45] This opening chapter gives you the background of the Gilbreth micromotion experiments.[46] By the way, particularly if you once studied Greek, you may know that *micro* refers you to the small details of motions.

2. *Chronocyclegraphs of motions.* The paths of typing motions, as you know, should be direct and short. To let you see a motion path, the Gilbreths attach tiny light bulbs to a finger or other moving part, so that the motion traces a path of light for the camera. Even the direction is clear, since this path of light shows as pointed dots or dashes. Do you follow this path of left-hand motion that returns the typewriter carriage in Figure 14? Is this the shortest, most direct path? Does the hand follow the carriage through or drop immediately to the keyboard? Could you improve on the path of this carriage return? The Gilbreths show you other photographs of motion paths, called "chronocyclegraphs," for a printer setting type,[47] a surgeon sewing up a wound,[48] and a laboratory worker.[49] Have these illustrations already shown you the difference between simple, short, sharp, expert motions and the hesitating, intricate lines of untrained motions?[50] You later see some of these motion paths even more concretely in wire models.[51]

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[41] Mogensen, A. H., *Common Sense Applied to Motion and Time Study* (McGraw-Hill Book Company, 1932).

[42] Gilbreth, F. B. and Gilbreth, L. M., *Motion Study for the Handicapped* (George Routledge and Sons, 1920).

[43] *Ibid.*, facing p. 2.

[44] *Ibid.*, facing pp. 45 and 49.

[45] *Ibid.*, facing p. 12.

[46] *Ibid.*, pp. 1–17.

[47] *Ibid.*, facing p. 13.

[48] *Ibid.*, facing p. 17.

[49] *Ibid.*, facing p. 28.

[50] *Ibid.*, facing p. 17 (A, B).

[51] *Ibid.*, facing pp. 20 and 21.

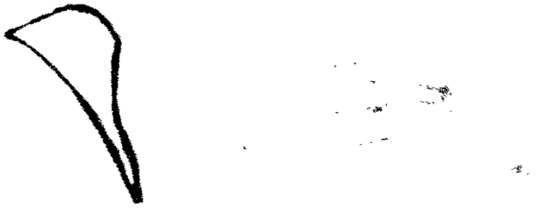

Figure 14. Gilbreth Chronocyclegraph of a Carriage Throw

The circular path of the throw is clearly traced by a tiny electric light on the left hand. (Adapted from *Motion Study for the Handicapped* by permission of Dr. Lillian M. Gilbreth.[52])

Figures 15 and 16. Measuring with Gilbreth Chronocyclegraphs

(*a*) Work paths (not of typing but of repeated folding motions), which visualize the decision, the loosely flowing curves, smoothness, and grace of correct left-hand motions.

(*b*) One-minute exposure of a speed typist working with correct motions. Notice that the electric lights on head and arms scarcely move, showing the absence of motion where motion would be wasted. (From Dr. Lillian M. Gilbreth)

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[52] Gilbreth, F. B. and Gilbreth, L. M., *Motion Study for the Handicapped* (George Routledge and Sons, 1920), p. 14.

3. *Gilbreth simo charts.* Now that you have thus visualized the path of typing motion, the Gilbreths are ready to explain how you visualize simultaneous use of many muscles at once.[53] For your own motion study of the carriage return or of paper manipulation, for example, you will want to plot a Gilbreth *simo* chart.[54] This small word is an abbreviation in the English style for "simultaneous-motion cycle chart." It will enliven your chart if you color its parts in striking fashion, as explained in Table XXIV.

TABLE XXIV

COLORS ASSIGNED TO MOTION ELEMENTS IN THE PREPARATION OF SIMO CHARTS
(From Gilbreth[55])

Motion Element	Color	Motion Element	Color
Search	black	Inspect	burnt ochre
Find	gray	Preposition (for next operation)	sky blue
Select	light gray	Release load	carmine red
Grasp	lake red	Transport empty	olive green
Transport loaded	green	Rest (for overcoming fatigue)	orange
Position	blue	Unavoidable delay	yellow ochre
Assemble	violet	Avoidable delay	lemon yellow
Use	purple	Plan (next motion)	brown
Disassemble (take apart)	light violet		

In the Gilbreth reading you have a chart of a former amateur typist champion while changing paper.[56] Study this chart until you visualize just what fingers, forearms, eyes, and other body parts were doing together as paper was ejected with the right arm hand and inserted into the typewriter with the left. You can easily duplicate such a chart as soon as you know the exact time each finger and each body part is in motion. You find this time by watching the clockface pointers change in a slowed motion picture of the movements. In the sample, these clock readings are at the extreme left of the chart.[57] For your own drafting, you color the chart space under whatever body part you observe in motion. The longer the time, the further down the chart you extend your colored line. When you are done, you know exactly what parts were in motion together and for how long. Then it is fairly simple to figure out any needless waste of time by any body part. In the amateur champion's paper handling,[58] for example, notice how the right hand has to wait while the left is bringing up the paper. Shouldn't you want to cut this out of your own paper insertion? Isn't it clear how vividly the chart works? In fact, the Gilbreths advise you to plan your typing moves on charts much as a chess player moves his men in chess.[59]

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[53] *Ibid.*, pp. 29–35.

[54] See Gilbreth, L. M., *The Home-Maker and Her Job* (D. Appleton-Century Company, Inc., 1927), p. 115.

[55] *Ibid.*

[56] Gilbreth, F. B. and Gilbreth, L. M., *op. cit.*, facing p. 31.

In your reading you now skip to a closing summary of points in teaching the blind typist.[60] These pointers apply equally to the seeing typist. Most of your typing, too, is by touch. Perhaps you include the bit on dictation;[61] then some ten pages will have neatly summed for you the approach to typewriting through motion study.

For further details you will wish to scan the pages of Mogensen and glance at the occasional pictures scattered throughout. These run from the opening account of *make ready, do,* and *put away* in process charts to the closing sketch on cameras. Here you find the dissected Gilbreth motion elements, such as *play for position, use, transport empty, avoidable delay,* called (with letters reversed) "therbligs."[62] These motion parts are defined. Their usual symbols are easy to remember and draw.[63] In your own charts, however, descriptions can be attached instead of symbols. After practice in charting you may prefer to use these brief signs and omit full description. In the meantime, stress the therblig "use" and its relations with paired therbligs.[64] Of course you are also urged to note the role of fatigue and monotony.[65] A

[57] Gilbreth, F. B. and Gilbreth, L. M., *op. cit.*, facing p. 31.

[58] *Ibid.*

[59] Gilbreth, F. B. and Gilbreth, L. M., *ibid.*, p. 34.

[60] *Ibid.*, pp. 148–158.

[61] *Ibid.*, p. 163.

[62] Mogensen, A. H., *op. cit.*, pp. 88–91.

[63] *Ibid.*, p. 89.

[64] *Ibid.*, pp. 93–94.

[65] *Ibid.*, pp. 96–97.

convenient list of principles briefly sums up the search for the "one best way" to do work.[66] Next, in detail you are told how to make a simo chart from a slowed film.[67] Incidentally, on the time-study side have you noticed a new time clock (microchronometer), and on the motion-study side, an interesting simo chart of a department-store cashier making change?[68] There is another step to the simo chart. As you take out hesitations, avoidable delays, longer times, poorer sequences, you are planning better motions which can be pictured in a *possibility chart.*

After you have finished with these two brief readings, doubtless you are eager to make simple charts of your own. All that is urged is that you practice such charting until you really do visualize this breaking apart of motions for the sake of putting them together in better typing ways. Try out a carriage return or paper insertion or removal or compare the time of a shift-key stroke with letter-key strokes. Whenever you and a classmate get together and study your carriage return, even if with a stop watch only, you may arrive at motion parts somewhat as follows:

(1–2) Three or less key strokes before a line's end, with or without a faint warning bell, your left hand leaves its home row to strike the carriage-return lever. It moves swiftly and easily up a direct, slightly curved path (*transport empty*), attended by such details as wrist held down and elbow held in. Glance again at the chronocyclegraph of such a path. If you are practicing your first carriage returns, with eyes on copy, you would also have to *search* and *find* before reaching the lever. Such hesitations soon vanish.

(3) The left hand contacts the return lever with the index finger (*grasp*). There is a natural cushion by the end joint of this finger, to catch the lever.

(4–5) The left forearm hand throws the carriage (*transport loaded* and *release load*). How about your thumb? Is it out of the way? Are all four fingers together in support of your index finger? The fast, sharp blow of your fingers moving rapidly with power from the forearm and their own momentum gives just enough momentum to make the carriage slide down its rails and click against the margin stop.

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[66] *Ibid.*, pp. 98–99.
[67] Mogensen, A. H., *ibid.*, pp. 104–106, 109.
[68] *Ibid.*, pp. 87–88, 134, 136.

(6) The left hand does not follow through, but instead, in its circular sweep, drops down a direct, slightly curved path. This *ballistic* descent to the home keys can be very fast (*transport empty*).

(7–8) An immediate play for position for the next stroking follows (*pre-position* and *use*). The right hand, which has been idly loafing (*unavoidable delay*, partly perhaps *avoidable delay*), also plays for position to enter the stroking. At the moment the carriage clicks, the fingers should be typing.

Does your carriage throw have the appearance of a single, smooth movement as your hand sweeps along the somewhat circular path that takes in the lever and moves on down? Do you follow all this in the description and in Figure 14? It is not unusual for novices to waste five or ten seconds on each throw. This is absurd, since its usual time ratio ought to be less than seven key strokes.[69–70]

Is your way clear to draft simple, similar charts? Here is a brief report of a left shift-key stroke. To plot this chart, use one time division on the clock for each square of cross-sectioned paper. The stroke starts at 30 and ends at 44 on the clock. The time is thus 14 clock divisions.

(1) From 30 to 40, or for an elapsed time of 10, the fourth finger leaves the home row (*transport empty*) to the shift key. (The color for the fourth finger column is olive green.)

(2) From 40 to 41, or an elapsed time of 1, the fourth finger depresses the shift key (*grasp*, in lake red).

(3) From 41 to 42, or an elapsed time of 1, the fourth finger presses the shift down (*use*, in purple).

(4) From 42 to 43, or an elapsed time of 1, the fourth finger releases the shift (*release load*, in carmine red).

(5) From 43 to 44, or an elapsed time of 1, the fourth finger returns to the home row (*transport empty*, in olive green). (Under which of these colors do you at once suspect wasted time and motion?)

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[69] See also White, W. T., "Carriage Return Drill," *The Rowe Budget* (1930), Vol. XXXII, p. 11.

[70] See also Smith, H. H., "The Teaching of Typewriting," *American Shorthand Teacher* (1930), Vol. X, pp. 355–357.

Can you apply the account of variables in your stroking to your paper change, after charting this illustration of a paper insertion finished in 3 seconds? Here it is.[71] Question any time spent in waiting or traveling instead of doing, even though the travel is less than an inch or you see no way to avoid the delay.

Clock Divisions	Description
0	Left hand moves to paper; right hand delays while left gets paper
10	Left grasps paper
11	Left carries paper to typewriter
33	Right moves to roller knob
34	Left positions paper under roller
43	Right grasps knob
44	Right delays while left hand positions paper under roller
47	Left releases paper
48	Left moves to edge of paper at front roller
51	Right twirls roller knob
60	Left grasps paper
61	Left straightens paper
74	Right releases roller knob
75	Right moves to paper-release lever
79	Right grasps paper-release lever
80	Right holds release open
87	Left releases paper
88	Left moves to keyboard
92	Right releases paper-release lever
93	Right moves to keyboard
100	

4. *Your motion studies.* In order to gain the assurance that comes from a first practical workout in motion study, try inventing a fast, continuous movement that inserts and removes paper, with both hands working. Otherwise you will waste several times over the time really needed. The work of the left hand in bringing up the paper will not balance the work of the right hand in twirling the paper into the machine. What you do will lack ease and rhythm — a distinct beat at grasping the paper and a distinct beat as twirling starts. Paper removal and insertion of the new sheet are possible with the expert in less than 3 seconds, although the usual typist may linger 10 seconds more or less.

[71] Blakelock, R. M., "Measuring Office Output by the Micromotion Method," *Office Executives' Series* (American Management Association, 1929).

Out of your trials of paper removal should develop a way that makes it easier to work both hands together and put on speed. Have you yet accepted, for instance, either of the two trials now briefly sketched?

Trial I. (1) Your left hand speeds to grasp the left platen knob. Your right thumb and fingers sweep up to grasp the typed sheet. (2) You grasp the side edge. (3) Your left thumb and first two fingers quickly twirl the paper out, while your right hand starts downward with the typescript. (4) While your right thus carries the typed sheet to the table face down, your left is also dropping to grasp a fresh sheet. (5) Your right releases the typescript, then moves to the right platen knob. If you are competing against yourself, can your left have the fresh paper at the machine before your right can twirl the platen knob?

Both hands have been working together, but isn't it faster to use the paper-release?

Trial II. (1) Your left hand speeds directly for a new sheet of paper. Your right index finger moves to pull down the paper-release lever (for a moment without locking if the lever permits). (2) Your right thumb and fingers move to grasp the typed sheet from the side. This right hand (3) grasps, (4) carries the sheet to the table print side down, and (5) releases it. At the instant this right is ready for twirling, will your left have the fresh sheet in position?

In fact, what has your left hand been doing in the meantime? (1) Your left has dropped with an easy, fast motion directly to the new paper supply. Already you have done away with any wasteful hunting motions (here or elsewhere).

(2) You grasp the paper with your left. Have you already found the best point at which to grasp a sheet of paper and hold it nicely balanced? Surely you will not take hold at the top that is farthest from your body. The point of the paper nearest you, however, is not nearest to your machine. Probably you compromise on the balanced point about the middle of the left edge of the paper. Have you already found a fast way to grasp paper? Try to make a "grasp" as fast as a "release." Hurry the thumb over the sheet(s) and the rest of the hand under the sheet(s), until checked by the edge of the paper. At this moment the inside of the hand, wrist, and lower arm will face the machine and also form a straight line from the elbow.

(3) Carry the paper rapidly to the machine with the least and easiest motion possible. Study to cut down the time, for you probably are keeping your right hand idly waiting.

(4) Your left hand slides the paper down squarely behind the roller as far as it will go, and carefully holds the left edge of the paper close against the side paper guide. Most machines have side guides or zero lines. A little care for this left edge brings the paper exactly in the middle of the platen. This is called *centering* the paper. If the sheet is coming in nicely centered, then you can work with sureness and ease. You can balance all your typing from this middle point (usually at 40) on your line scale.

While your left has been working, how long has your right hand idly loafed? Already this hand has moved easily to grasp the right platen knob, with its thumb well under on the near side and the first two fingers well up on the rear side of the knob. Are this right hand and forearm now parallel to the machine? Is your right elbow further forward but no further out from your body than in stroking?

(5) Your left hand releases, and the moment that the paper is free, a quick, easy flick of this right knob twirls the sheet into the rollers. The twirl feeds the paper into your machine up to the exact top margin wanted. Your right thumb guides the twirl from its hold on the near side of the knob. Study to make this twirl fast yet easy, for you must not make the mistake of thinking that tremendous effort is a sign of efficiency.

As the paper comes up, you (6) inspect. Your eyes have been sighting above the front roller scale to watch for an even top edge of the paper as it comes up in front. Its edges should be straight and even above the scale. Are you sharp of hearing? Perhaps your ears can help your eyes bring this paper up just the right distance for a top margin a little wider than at the sides. Six clicks of the ratchet make an inch of distance. If you can separate 10, 15, 20 clicks, try the different top margins that result from each. Otherwise you may have to take time out to stroke the left line spacer. This feeds the paper forward. You might even have to bring the right hand to your aid by twirling the paper forward or back with the knob. In fact, you may prefer to position the top margin by counted strokes (perhaps 9) of the line-space lever as soon as the top of the paper appears. (If you use a bail machine, the left hand must also guide the paper under its frame.)

If you are clever or lucky, the paper comes into the machine just the right distance for your top margin. Above all, the paper is also straight.

In this simple way you avoid all the wasted motions needed to straighten paper or to find a top margin. Already your fingers (7) have dropped to regular positions and you are typing copy.

As you twirl paper in and you sight above the front roller scale to watch for an even top edge, it may be, alas, that the paper's edge is not straight and even. At once (1) your left thumb and fingers move to grasp the left edge of the paper, while your right index finger moves to pull the paper-release lever just far enough to free the paper. Don't keep your left waiting.

(2) This lever is pulled, and your left holds, also straightens the paper.

(3) The lever and paper are released. The paper is straight, and you finish turning the sheet into the machine until it is up the desired inches above the front scale.

Now it may happen that your paper is so far from straight that you need both hands to restore it to an even edge. Of course, your right index finger then locks the paper-release lever, and your entire right hand flies to assist your left. Both left and right hands now straighten the paper. Is this wasteful or is it not? A new typist with a fumbling left hand often feels that he has to use both hands.

The instant the sheet is straight, the right hand hurries back to return the paper-release lever. The paper is twirling up above the front scale. The hands swiftly drop back to stroking copy again.

In a similar manner study to find a faster way of inserting carbon papers. For example, Smith[72] suggests that you start a pack of paper sheets into the machine two or three spaces after the rollers grip the paper. Pull the first sheet forward and drop in a carbon; continue until you are ready to twirl the whole pack into your machine. In removing this paper the carbon ends still protrude, so that all can be grasped by the right hand and separated out with a single movement. Or else, do not overlook such tricks as inventing a paper trough, perhaps by folding lengthwise a quarter of a sheet of paper. Drop five or more sheets into your folded trough, to insert as you would one sheet of paper.

Apply all the past cleverness that you have learned about changing paper to the art of carrying cards into your typewriter. Can you find and use any card-writing attachments?

Apply the same cleverness to the art of carrying envelopes into your typewriter. Can you find and set your envelope guide? Will you feed from the left with a fast motion, much as you insert paper? As your right hand twirls in one envelope, can your left drop another envelope right behind, so that both are carried in? Can you catch your first line of typing so that the center of your envelope is held somewhat above and to the left of what is shortly to be the center of your balanced address? Concentrate on reading the address copy and at once type it altogether from memory. This saves considerable time. As you type, try a Boy Scout turn and save time for the postal clerks. Can you remove each envelope with equal cleverness?

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[72] Smith, C. C., *The Expert Typist* (The Macmillan Company, 1922), pp. 40–42.

Everything about typing is designed to make it easy and fluent for you to communicate with others. This fine ease applies even to the folding of your personal letter. Even simple folding in factories has long been illumined by motion study.

Throw the bottom of your letter over toward its top. This first fold varies with the size of envelope. For a personal 5½″ by 4½″ envelope, a simple fold that leaves the bottom edge almost at the top will suffice.

For the larger 9½″ by 4½″ envelope, two lengthwise folds bring the bottom within a ¼-inch of the top.

Study your folds for the usual 6¾″ by 3½″ envelope. Use both hands and at times hold the paper with the one while the other creases. Try to feel your hands move in easy curves, until you iron out all jerkiness. Use your eyes to catch the exact spot for each fold, until hesitations disappear.

When you fold a letter, co-operate with your reader, who must open your fold. How close can you come to a self-opening letter? Try various folds to match this usual 6¾″ envelope. As you fold the bottom edge over upon the top, why not leave from ½″ to ¾″ of this top?

As you take advantage of your final fold, decide whether it is easier to open your letter with a shake of the right or the left fingers. (1) You might fold the left edge over less than a third (to leave its edge slightly past the center). Then why not bring the right edge out ½″ past your left-hand fold? (2) Or after folding a third of the sheet from right to left, why not leave the left edge fully ½″ from your right-hand fold?[73]

In the light of this overview of all typewriting, transform your typing studies into motion studies. As you view each slow-motion film of a working typist, perhaps from the vantage of a small, co-operating group, jot down the clock times for motions in which you are specially interested and plot them, if needed, upon a motion chart. Then at your leisure check over each motion part. Check every such motion element for hesitation and excessive slowness; in fact, question the very necessity of its presence. Perhaps it is not needed. Perhaps it can be lightened. Plot both hands and at your leisure watch what both hands are doing. Perhaps one lags or suffers avoidable delays. Compare several charts of the same kind of motion on different occasions, perhaps drawn by other students. Try to see how each performance differs and select its shorter and smoother motion parts. Thus a new sequence emerges and you find a surprising change for the better, with new cleverness in deliberately discarding inferior motions and substituting superior ones. Soon you will agree with Benge[74] that the very possibility of this improvement varies directly with the degree to which your work is analyzed. You will become motion-minded.

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[73] Wood, E. H., *op. cit.*

INTERPRETATIVE SUMMARY

Problem solving along a charted path of motion studies has now been surveyed in detail. Control of complicated typing variables in general and of Gilbreth variables of the motions in particular has been rehearsed. Reading references chosen with great care from statements by the Gilbreths and Mogensen are included. Every young typist is urged also to survey his performances in typing cycles as complete wholes by thoroughgoing analysis with the aid of the Gilbreth "therbligs." By charting superior and inferior motion steps for many muscle groups at once, each student improves his program for eliminating waste motion and avoidable delays. The outcome should be genuine insight into what motion study is all about. Actual working out of the student's motion follows.

By determining the nature and the sequence of the elements of correct fast motions, it is possible to spare the student much of the early "trial and error" in the acquisition of skill. Possibly you have seen the golf "professional" who starts his student on the mastery of a superior swing with one club. By demonstration and practice the student learns to swing the one club until a satisfactory performance is secured. Only then does he swing at a real ball on a real fairway. If all the elements of the swing are mastered in their proper sequence, it is entirely feasible for the first attempt on the fairway to resemble the swing of the expert.

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[74] Benge, E. J., *Cutting Clerical Costs* (McGraw-Hill Book Company, 1932), p. 96.

Correct motions of typing experts, however, are too rapid for the human eye unaided. The short cut developed by the Gilbreths to extend the human eye by the slow-motion camera enables student typists actually to see correct, fast motions in order to profit by the likenesses between experts. Only in the slowed motion picture can the motion of the expert be slowed with its form preserved. These slowed motion pictures, photographs of motion paths, charts, instruction sheets, and demonstrations permit visualization as the readiest short cut to classroom insight into the clear-cut patterns of motions.

CHAPTER XI

DISCOVERIES ABOUT TYPING SPEED

* * *

READING SUGGESTIONS

To the Student Typist: In this short chapter clear up a few points. Catch the distinction between fast motions and a fast pace, page 286. Read to understand why slow motions are incorrect, pages 287 to 290. Note how you discard the slow, hunting motions first used on the keyboard, pages 290 to 292. Catch the idea of practice at your best rate of speed, pages 292 to 294. Notice three other points: that speed and accuracy are quite separate, page 294; that it pays to watch your gross test scores, page 296; that making corrections is not typewriting, pages 298 to 300.

To the Psychology Student: Here are added points under the topic of motion studies in applied psychology. You may want to emphasize pace in motor reactions, page 288. A high point appears in an outstanding triumph of the Gilbreth studies: showing that fast motions are different from slow motions, and the fallacy of "slow but sure," pages 287 to 290. You will be interested in psychological experiments with reaction times, page 291, serial-reaction times, pages 292 to 294, and proofreading illusions, pages 295 and 296. The view of learning as decreasing action to the minimum briefly reappears, page 300.

To the Typing Instructor: This chapter seeks to show why skillful student technique is the best guarantee of both speed and final accuracy. An overemphasis on accuracy at the expense of speed is analyzed, pages 284 to 290. A distinction is made between fast stroking and fast pace, page 286. You then read why correct motions have to be fast, pages 284 to 289. Substitution of fast for slow, finding motions, used while learning the keyboard locations, is outlined, pages 290 to 292. Practice at a student's optimal rate is recommended, pages 292 to 294; also use of gross test scores and lighter penalties for beginners' errors, pages 296 and 297. Corrections are divorced from fast typing, pages 298 to 300.

* * *

CORRECT MOTIONS COPY FAST MOTIONS

Thousands of typing students move forward under heavy clouds of overemphasis on accuracy. Possibly you too may feel this pressure, which arises in the queer notions prevalent about speed. Most of these ill-advised beliefs seem derived from two fallacies. First is an unquestioning faith in the value of slow-but-sure repetition. Next is the curious assumption that a beginner's typed work should be 100% perfect.

1. *The queer bias for petty accuracy.* Just why so many typing instructors, rather than throw away the first typewritten work of any learner, prefer to stress its accuracy as their chief aim remains one of the riddles in typing studies. To a practical outsider, this amusing early output should be marked for quick extinction rather than emphasis. Not *copy* but *technique* is what you and other student typists seek. The outcome worth your stressing is the successful typewriting which is to crown completion of the whole course. Fast, accurate typing is the desired final outcome of the typewriting course in high school and college.

Your daily output has little value in itself. It merely informs you to what degree you are rising towards the standard typing level which ends the course. As long as your conditioning is incomplete, errors may be expected as a matter of course. At the outset, to expect perfect accuracy is equivalent to an absurd demand that conditioning appear well developed from the very start. Many early errors are mere accidents and their disappearance in future typing is automatic. Errors disappear as the conditioning improves. When you first try an unfamiliar keyboard, fumbled key strokes are of no consequence so long as you still concentrate on the directions to key locations. Your action is excessive, yet you are learning to relax this excess away. Asking you to recopy increases this tension and makes matters worse. Misdirected key strokes are of no consequence so long as you still concentrate on the firmness of your stroking. These merely mean that some word is not yet automatic, but intelligent drill conscientiously followed will make it so at the proper time.

It is when an error bobs up repeatedly that it becomes a sign to pause until certain precautions are taken. Otherwise, asking you slowly and painfully to recopy would mean that you practice an incorrect movement. This would waste your time, and often it would destroy what useful conditioning you already have. Why is a practical pause needed? It is made to save time by thinking. Before practice proceeds, you should learn to attack this particular typing in a new way. You should profit by the repeated warning to find a motion pattern more in keeping with the final results of the course. Repeated errors become guideposts to new ways — to new, more compact typing patterns. Each successful practice helps build up the new typing patterns, until you, eventually, can use any finger stroking directly in new copy. This success has no relation to the hours actually spent before a typewriter. Many of these hours are at present wasted. Enough complete typing patterns eventually persist for you to achieve the fast, accurate output called *final outcome.* Of course this final typing represents a high degree of accuracy in order that you may turn it to practical personal and commercial uses.

Not accuracy but its exaggeration is here condemned, and for two reasons. In the first place, accuracy is overstressed at the expense of fast motion. In the second place, overstressed accuracy distorts your typing by a distorted view of essentials. What are these high points of typing? So long as you think of your typescript rather than of the motions that produce it, you will miss them and your view will be distorted. When you start to think of typing as motions rather than as typescripts, you begin at once to build fast motions. Typing speed grows, but fast motions must also be present from the start.

Typing speed offers a paradox. It is two-faced. It has to do with fast motions. You feel this speed in your fast rebound from each key. Eventually, it has to do also with fast rates. You start at once with fast motions. Typing speed will grow as fast motions are thrown together faster, with shorter and shorter intervals between motions. Motions are fitted together faster whenever the rate or pace gradually quickens. The motions themselves are always fast. This distinction is not fully understood until you study rhythm in the next chapter.

These separate aspects of speed are due to the fact that to typewrite is to form patterns in time. Time continues onward. Successful typing runs in a series of successive motions. This you already call *sequence.* It is this order in which your fast motions appear that has to do with accuracy. As rapidly as you are conditioned to bring out motions in a definite succession or order for definite common words, you gain in accuracy. It is a useful fact that a faster rate or pace, by bringing motions closer together, hastens this accurate conditioning as long as this pace can be maintained. Premature forcing of too fast a pace, however, outruns your control of the order needed for your motions. This invites disaster. It breaks up the typing. An intelligent compromise on the regular rate of typing practice is necessary. Fast motions are fitted together at whatever rate you are able to maintain. The speed of the actual motions, you recall, remains fast. Accuracy is not directly related to fast motions, but only to the serial order in which these appear. At once you start to condition these motions to a certain order in each common word. As you build up orderly successions for common words, your fast motions are gradually thrown together faster. This gradual growth in overlapping between fast motions as the pace gradually quickens is the high point of successful practice.

2. *Childlike trust in "slow-but-sure" repetition.* What does *slow-but-sure* finger poking have to do with fast stroking? Nothing! Then such amateurish repetition is mostly waste. To be sure, this slowing down in the face of typing difficulties is entirely natural. Indeed, it is readily observed among very young children. When Gates[1] tested the muscular speed and cleverness of fifty kindergarten children, he noticed that if they were in the least confused they slowed up to a safer speed. Several began very fast but on making awkward movements chose a slower pace. One youngster cried, "I shouldn't have gone so fast."

If you try for a false show of accuracy, however, by adding cautious, slow motions to a slow pace, then you will have nothing in the way of motions to fit together when faster typing rates are due. Slow motions cannot hold together under fast timing. When you finally attempt to bring your slow motions closer in fast timing, to use an analogy, your typing sticks on a dead center. All your previous slow practice goes to pieces in what are called "plateau blues," or the common, dead levels around 35 to 40 words per minute, where even advanced students are needlessly caught and held. Then you would painfully realize that slow-but-sure practice has been wasted time.

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[1] From Gates, A. I. and Scott, A. W., "Characteristics and Relations of Motor Speeds and Dexterity among Young Children," *Journal of Genetic Psychology,* 1931, 39. Pp. 423–453.

This notion that a slow-but-sure worker is more accurate than a fast worker survives even in business and industry. The fallacy has been tested out by O'Rourke[2] with his revised general clerical examination. His tested results show 125 slow workers, 38% accurate, and 125 fast workers, 80% accurate. The fast workers' production has also been five and one half times greater than that of the slow workers!

3. *Acquiring skills at correct speeds.* Moreover, you can actually observe in everyday life, notably in the world of sports, that activities which must necessarily be executed at a fast tempo (such as successful typewriting) cannot be mastered at their rapid tempo by slow and overcautious practice. In the motion pictures of athletes by Griffith do you recall that pace is the final difference between awkward and skilled movements? In discussions of the psychology of motor skills, Ragsdale holds that once you have the simple fundamentals, the best way to acquire speed is to practice the skill at the desired tempo. Golf is used as an illustration. In learning to drive your best distance, say 200 yards, if you followed the methods common in some typing classes, you would faithfully practice until you had 100% accuracy on 25-yard drives. Then you would practice drives of 50, 75, 100, and 125 yards in the same manner, until eventually you attained your best distance. That would be a slow and laborious technique, for the reason that each distance would have to be learned anew. The tempo of a 25-yard drive would be of little help in driving 200 yards. With

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[2] O'Rourke, L. J., "Relation between Speed and Accuracy," in *Handbook of Business Administration,* W. J. Donald, Editor (McGraw-Hill Book Company, 1931), pp. 802–806.

each increase of the practice distance, the extra energy needed would so disturb your balance, stance, and swing that you would have to start over, learning your drive anew. Why not wisely start a drive that tries for your best distance at the outset?

A young pilot learned to fly a slow, lumbering "Jenny" plane with a landing speed extremely slow for airplanes. After the first satisfactions of that attainment, he secured permission from the owner to fly a small, high-powered scout monoplane with a landing speed more than double that of the "Jenny." Imagine the consternation of attendants at the landing field as they watched this new pilot attempt to land. More than twenty-five times he would bring this flashy little plane toward the ground, then sensing what to him seemed too rapid a landing speed and fearful of over-running the field, would soar up again for a new trial. After more than an hour, realizing that he must land or run out of gas, this young pilot made a last and seemingly desperate attempt. As the machine finally bounced to a stop and his feet safely touched terra firma, his first comment was, "I just about concluded I'd have to stay up or else learn to land it!" This pilot's comment indicates that he agrees in substance with Ragsdale when it comes to acquiring skills at correct speeds.

4. *Gilbreth motion-study notes: correct motions have to be fast.* On the other end, likewise, watching the struggles of experts asked to type slowly would be too disconcerting if you still persist in slowing down motions in the name of some fictitious accuracy. Their predicament is obvious in this brief moment from the Gilbreth motion-study laboratory:

Mr. Gilbreth. Slowly. I know you can go slower than that.

Mrs. Gilbreth. From observation she seems to use entirely different motions. Asked to go forty, she doesn't succeed in going below sixty words a minute.

(*First Speed Typist* notes that her hands are not in the right position. She is in the wrong position, and therefore everything is slowed down.)

Mr. Gilbreth. The path of slow motions is entirely different from that of fast motions.

First Speed Typist. When I am using my fingers quickly, they are curled up and tense. When I am using them slowly, they fall back to the next position.

Mr. Gilbreth. I want you to write the practice sentence as slowly as you possibly can.

(Film is taken to show the relation of the hand and arm movements with slow motions. Apparently the typist puts *more* effort into the slow motions than the fast ones.)

Mrs. Gilbreth. Do you use more pressure when you go slowly than when you go rapidly?

First Speed Typist. Yes. I do it in order to write slowly. If I did it exactly the same way, I would have to wait longer between strokes.

Mrs. Gilbreth. I note it is a great help to her in slowing down if she speaks the words out loud, because she has to slow down her fingers to keep time with her speech. . . .

Mr. Gilbreth. I want to get her as slow as she can to show you she cannot go slowly.

(*Second Speed Typist* writes as slowly as she can.)

Mr. Gilbreth (to *Typist*). You are not typing slowly. You wait a long time between motions, and then you do them quickly.

5. *The new typist's slow motions are relaxed away in common sequences.* What of the finger motions if you slow down precisely into sluggish typewriting? Of these, the less said the better. Like your earliest typewritten work, all such finger motions are to be discarded, dropped, and forgotten as soon as possible. If you silently tell yourself or even permit your motions to fall back into slow-but-sure tapping that never brings desired results, you store up future disappointment.

The correct motions copy fast, not slow motions. Yet you bring to class the "hunt-and-peck" system with which any untrained person first tries out the typewriter keyboard. While the keyboard remains unfamiliar, you continue to rely more or less on these slow, hunting motions that you first bring to the typing class. Yet the transformation of such awkward finger strokings commences even while you are mastering this unfamiliar keyboard. Because correct motions are fast motions, speed is here sought from the first days.

How, then, are changes in your motions to commence at once? In the first place, during dictation your eyes are able to locate and guide your finger directly to the right key.[3] In the second place, you are shown a correct, fast stroke and coached to discover a like stroke for yourself. Its feature is your fast getaway from the key. In the third place, fortunately, your slow, awkward, excessive motions by arms, hands, fingers, and body are largely relaxed away as fast as you discover and apply partial relaxation. What helps? What makes faster typing motions possible? Why are the correct strokes shorter, sharper, faster than slow single strokes? The answer is simple. It is the use of sequences. How is it, you ask, that familiar word sequences increase speed? The answer is that even with a two-letter sequence, while the first finger is stroking, the second finger is starting its play for position and overlapping its stroke with the first. A two-letter sequence is thus the smallest practical unit of motion in typwriting. Long ago Wells[4] showed that strokes in errorless typing are shorter than single strokes because of this overlapping within each sequence. By a collection of 70,000 reaction times, Gatewood[5] has added further definiteness to this fact. A mere glance at Table XXV should convince you that single-finger stroking is slower and less accurate than two-finger sequence stroking, with the further implication that what happens is even more helpful in the longer sequences of successful typewriting. Not only are successive finger strokes faster than

TABLE XXV

SUPERIOR SPEED, IN PERCENTAGES OF TAPS FASTER THAN 400 SIGMA, OF TWO-FINGER OVER SINGLE-FINGER TAPPING, 7 SUBJECTS
(From Gatewood[6])

Two Fingers	89	76	74	74	68	46	41
Single Finger	78	54	59	55	43	28	28

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[3] See Part Two, pp. 169–183.

[4] Wells, F. L., "On the Psychomotor Mechanisms of Typewriting," *American Journal of Psychology* (1916), Vol. XXVII, pp. 47–70.

[5] Gatewood, E. L., "Individual Differences in Finger Reactions," *Psychological Monographs* (1920), Vol. XXVIII, No. 126.

[6] *Ibid.*

isolated strokes, but still greater speed follows if the successive fingers are on opposite hands. Here is a student, for illustration, whose ratio of two-finger speed is 55 on the left hand, 65 on the right hand, and 74 with both hands. Isn't this what you would expect? Of 45 fast finger combinations, 68% are on both hands, 26% are on the right hand, and 6% are on the left hand. Other possibilities appear. The third left finger seems fastest when combined with the right index finger; the left second finger seems fastest when stroked with the right third finger. When two fingers react in immediate succession, you are doubtless ready to conclude that the speed of a given finger may vary, depending on what finger reacts before or after. The typing interval is the time between two successive strokes. This matches the interval between the release of one key and the engaging of another key by the machine. This is why at the very outset, if you must drill a certain key stroke, you drill very short sentences having common words deliberately chosen because each repeats that particular letter. From the very start, familiar words carry and speed your stroking. Such conditioning becomes automatic and remains usable.

YOUR OWN OPTIMAL RATE OF SPEED

As you practice word sequences, preferably in their line and sentence setting, you move toward a valued, essential, personal discovery — your own optimal rate. You find that your motions are most normal at your own best rate. If you are already a superior typing student, you find practice at the slower class rate increasingly irksome. A fast typist, likewise, who slows far below his optimal rate, runs the risk of more errors unless this is done for some definite purpose, such as increasing the firmness of his stroking. More errors likewise follow if he tries to write above it.[7]

Within limits, however, the loss in accuracy with increased speed is relatively slight. It is only when speed becomes excessively fast that errors accumulate by leaps. This fact is illustrated on a very simple scale by experiments in thrusting and also in tracing a simple maze.[8] The speed of motions started at one metronome beat per second has been gradually increased until quadrupled at a beat every quarter second. At the slow pace a natural fault has appeared — carelessness. Even with the pace doubled, errors have increased only some 7%. But at four times the pace, roughly half the motions were false.

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[7] Wells, F. L., *op. cit.*

Closer to your common interest in typewriting, however, are the experiments in psychology with serial-action tests. In Hanson's [9] study of such finger motions, his students react to a signal by striking the correct key, either *y* or *t* or *u* or *i*, on a typewriter. In this kind of serial reaction a key must be struck *before* the next signal appears. Of course such isolated striking is not typewriting. The next stroke is unknown, and its start is arbitrarily delayed. Naturally, Hanson finds that success here has little relationship with typing-class scores. A single, isolated reaction time is notably slower than successive typing strokes that overlap. Incidentally, differences in simple reaction time between any of the fingers after practice are slight. Rather, it is the time of a slightly used finger which is longer. This is one reason why the new student has been advised to practice all four fingers from the start. To get on with the story of this experiment, Hanson soon notes that his student with the most gain in speed declines least in accuracy. Individual differences in speed, too, would grow less, but not disappear.

In short, the speed of serial finger motions increases rapidly for the first twenty-five to thirty attempts, with fewer ups and downs in speed as the student strikes his "gait." Indeed, students who work the fastest show the least variability in speed. As a student becomes more familiar with the serial-action test, he loses caution and tends to keep up a fast, automatic gait that sometimes, but by no means usually, is at the expense of accuracy. This Hanson calls the *personal equation* of speed in serial action. Here it is again, slower than in your own typing, but an equivalent fact — a personal, optimal rate of speed.

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[8] Garrett, H. E., "A Study of the Relation of Accuracy to Speed," *Archives of Psychology*, No. 56 (Columbia University, 1922).

[9] Hanson, C. F., "Serial Action as a Basic Measure of Motor Capacity," *Psychological Monographs* (Princeton University Press, 1922), Vol. XXXI, pp. 320–382.

Have you discovered your own best pace in typewriting? Then you ought to be able to hold this gait without undue sacrifice of accuracy. Now and again does this pace of yours rise? Why let any pace grow too settled at this stage of your practice? Experiment with faster rates. Keep abreast of whatever is a faster, optimal pace for you.

NATURAL FLUCTUATIONS IN ACCURACY

1. *Errors as interruptions of sequence speed.* Suppose you do maintain a faster, optimal pace, yet up pops an error. What is the chief result of this error? In the conventional typing class, it is a penalty and red mark toward a lower "grade." Underneath these school trappings, what really is the result of the usual error? It is chiefly that it slows the sequence speed. That is its worst offense while you are a learner at school. In fact, your error was probably an effective stroke. You simply directed it to the wrong key. This fact Wells[10] has made transparent. The error often blocks your typing, though he finds this noticeable blocking is seldom over one and one half seconds. The usual errors are very transitory breakups of the speed of whatever sequence you are typing. This blocking does not always occur. It is a further fact, Wells[11] observes, that with the slower typist the errors are also slower. Notice, too, in a measurement[12] of slow typewriting, that two-letter combinations faster than 2.5 strokes a second average only .3 error per 100 key strokes, while the slower two-letter combinations average .7 error. It begins to look as if slow stroking continues to be inefficient, hence objectionable, like isolated letter stroking, in the guise of errors.

2. *Independence between speed and accuracy.* Although the usual errors interrupt the speed, many have tried to find, but no one has found, any real relationship between faster time and more errors.

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[10] *Op. cit.*

[11] *Ibid.*

[12] Bramesfeld, E., "Untersuchung des Anschlages an der Schreibmaschine," *Industrielle Psychotechnik* (1929), Vol. VII, pp. 224-225.

The fast typist tends to be either accurate or inaccurate. The inaccurate typist tends to be either fast or slow. The utmost hint that it is possible to give you is that the very slow typist tends to be inaccurate while the very accurate typist tends to be fast.[13] Do you recall Hanson's[14] important experiment concerning serial reaction on four typewriter keys? Your rank in speed would not show your rank in accuracy on these four keys. Nor would faster or slower time in any one test consistently mean more or less errors. For illustration, 26 college girls studying music practiced striking the keys in series as certain numbers appeared, later as certain tones were sounded. If a girl grew painstaking at the expense of speed, she was urged to a faster speed. Likewise, if a girl made over 5 errors, she was cautioned to be more accurate. These girls increased their serial-action speed 25% within 25 trials, without loss in accuracy. Speed does not develop at the consistent expense of accuracy. Nor does accuracy need to hamper the rise in speed.

3. *Wasteful accuracy instructions in proofreading.* An oft-summoned chore in typing class is proofreading of your typed sheets. Of course, you miss some errors. How are you instructed to proofread for the purpose of counting your errors? Are you asked to be "accurate" or to be "fast" in your count? Will it surprise you to read that asking you to be "fast" would bring somewhat better results? Perhaps Crosland's[15] experiment in the field of proofreading will help dissipate the halo around wasteful overaccuracy.

Proof is first read for accuracy. Similar proof is next read for speed. If you are inexperienced in checking errors, the "accuracy" aim produces much smaller gains. Under "accuracy" instructions beginners made 53% more errors than proofreaders of experience. Under the change to "speed" instructions these beginners made only 42% more errors than the old-timers. Under "speed" instructions Crosland sees the inexperienced proofreader (whom you might liken to the inexperienced typist) more at home and his loss in accuracy less than his increase in speed leads one to expect. These beginners, indeed, remain more than a fourth faster than the regular proofreaders. The latters' early training in slowness does not even pay for itself in accuracy returned. Spending enormous amounts of time on most attentive proofreading gives no one 100% accuracy. On the contrary, it looks surprisingly as though the usual proofreading is wastefully slow. Too many proofreaders seem habituated to slow reading and show distinctly less skill if asked to speed. Would you venture this criticism of many typists?

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[13] See Thurstone, L. L., "The Learning Curve Equation," *Psychological Monographs* (Princeton University Press, 1919), Vol. XXVI, No. 114.

[14] *Op. cit.*

[15] Crosland, H. R., "An Investigation of Proofreaders' Illusions," *University of Oregon Publication* (University of Oregon, 1924), Vol. II, No. 6.

With proofreading, as with typing, you cannot predict the inaccuracy by noticing how speedily the proofreading is being done. In both skills it seems fairer to weigh both the accuracy and the time consumed.

4. *Gross typing scores and limited-error plans.* You will want to protect your speed by keeping continuous track of your slowly rising scores on the speed tests. You will want to watch your rising gross scores equally with your net scores. By contrast, even carefully planned schemes for your test records may doubly penalize your speed.[16] Even the celebrated International Contest scoring rules, with their impressive classroom penalty for each error, are tempered by the fact that gross scores still give the more correct picture. This early bias toward accuracy at the expense of speed may be somewhat offset by compromises. Until the slower speeds are surpassed, in fact, a ten-word penalty per error brings mostly tragic yet amusing zero scores. The Harned[17] student, accordingly, deducts for each error one half his gross rate per minute. You may be familiar with the Ross limited-error plan. On standard test copy for 5 minutes, you are allowed 5 errors during the first semester. On standard 15-minute test copy, you are allowed 10 errors during the next semester. With penalties lightened to permit 3 errors per sheet and 1% loss in grade per error, Rady[18] finds

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[16] As in Leonard, G. F., "Rating Scale for Speed Tests," *Balance Sheet* (1930), Vol. XI, p. 236.

[17] Harned, W. E., *New Typewriting Studies* (Ginn and Company, 1930), p. 43.

[18] Rady, I. L., "The Most Effective Use of the Typewriting Class Period," *American Shorthand Teacher* (1932), Vol. XIII, pp. 13–16.

that better work is produced. In any event, this repeated watching of your speeds in the light of error checks moves you toward the essential self-discovery already outlined — your own best pace.

5. *High quality of final outputs.* A curious little experiment by Sturt[19] is quite suggestive as to how much any early penalizing or fussing over your "careless haste" would really amount to. This teacher found that children who had been making over 80 mistakes in a page of typing can, in three lessons, reduce these to 9 mistakes, with only a small decrease in speed. Doubtless you have already guessed that Sturt compared a "speed" group working for speed and an "accuracy" group working for accuracy. This study ran to extremes. Of a score of little girls, ten were told that speed is more important for a typist, that all marks and prizes would be given simply for speed. Mistakes were never mentioned. Nor were their old papers ever shown. Of course, for the other ten girls, all was in reverse. Nothing was said about speed. They were constantly shown their papers with all their mistakes corrected. Apparently, their teacher had to exert considerable "influence" on this "accuracy" group. There was more abundant, maybe constant, rebuking and more unpleasantness.

The "speed" group naturally was piling up errors in more terrible fashion each week. By late spring, however, when instructions were reversed, the "speed" group acquired at once almost the accuracy of the "accuracy" group without appreciable loss of speed. If quality of the *final* output is the important matter, the typewriting class can be much more pleasant for you and any teacher, too, by neglecting minor fluctuations in accuracy. Such ups and downs are natural and normal — 100% perfection is not. With the "accuracy" group the ups and downs in accuracy, as compared with speed, have seemed about double the ups and downs of the "speed" group. Sturt[20] concludes that a high *final* quality of work is possible without insisting on a high quality constantly throughout the learning.

[19] Sturt, Mary, "A Comparison of Speed with Accuracy in the Learning Process," *British Journal of Psychology* (1921), Vol. XII, pp. 289–300.

[20] *Ibid.*

CORRECT MOTIONS FIRST, SPEED SECOND, ACCURACY LAST

1. *Typing speed* versus *corrections.* The Gilbreths[21] offer you a most practical distinction. Correcting misdirected strokes or having the teacher correct your work is not typewriting. From the start you should stop to correct or do over correctly or have the teacher correct your work, without confusing this correction with typing. A final penalty of 50 strokes per error can be justified only as very approximate to offset not only the break in typing speed, but also the time wasted when your final outputs still require backspacing, erasing, and inserting a correction. Time the motions of a correction together to see whether they exceed your usual time for typing ten words. Such a penalty, separating typewriting from correcting, applies with even greater force to complete "retyping." Obviously, the loss of time is then far greater.

Surely you have observed friends who take more time to make ready to do something and to clear away later than they use in the actual doing. You may be struck by the similarity between time used for corrections and time used for *get ready* and *cleanup.* Apart even from errors, without definite precautions, you doubtless waste some time in *get ready* and *cleanup.* This leaves less time for the actual *doing,* or typing at correct speeds. This may force you to exceed your best rate or to leave a typing job unfinished. It is not hard to look on any correction of errors as in the nature of a prolonged cleanup. As a student of motion and time study, you should always be an intelligent critic of effort and time lost in excessive make ready and cleanup, as contrasted with typing.

The necessity for actual corrections in personal and business typing is recognized at the same time that this injury to the total typing speed is deplored. Corrections, it is true, are a part of your typing course. Yet the entire period of your training should serve to reduce this need in your final output when the course is finished.

Actual corrections in your typescript demand certain detailed precautions. Here are several examples of such precautions.

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[21] Gilbreth, F. B. and Gilbreth, L. M., *Applied Motion Study* (The Macmillan Company, 1919), p. 112.

You move the carriage to the end of the rails so that erasings will not fall amid type bars. You place a blotter (or other defense) immediately under carbons to protect against pressure prints as you erase. You may even improvise a homemade eraser shield out of heavy bond paper or used camera film, with an eyelet, to protect against needless erasing and fingerprints. Corrections, in fact, demand some special study. You then discover easy and frequent side-to-side motions while erasing, in order to keep the paper tissues intact and the line setting normal. You discover a lighter stroke for the correction, to avoid a dark letter on erased paper. You learn to turn the paper, especially a paper group holding carbons, back to the line with a careful motion that keeps paper or pack from shifting on the roller. To make sure, you inspect the distance between the line of writing and the platen scale just below it before retyping. Carbon-copy erasing itself, incidentally, is fairly elaborate when the pack is turned up several spaces, paper clamps, perhaps a bail, thrown back, and blotter inserted. If the paper does shift, at least you have an opportunity to apply motion to the paper-release lever or to the variable line spacer while you fit a correction into its exact space division.

Your study grows more elaborate if you must first reinsert the typescript into the machine and reset the line on the platen scale, or if you must crowd four letters into the space of three originally, or make similar alterations. With a fractional line spacer you can cut off half the space at the beginning and ending of the word. Otherwise, you must hold the carriage or backspacer and practice crowding the strokes into the required space. This brief review of such corrections, with their painstaking attention to detail and to the typescript, further separates such operations from the actual typewriting at your best rate of speed.

2. *Correct, fast motions for accuracy.* The brilliant insistence of the Gilbreths on standard motions at standard speeds first, with quality of the output second, seems inevitable as soon as motion study is substituted for traditional complacency. Well over a decade ago the Gilbreths successfully put to rout the reverse view hitherto generally accepted. Their photographs concretely show that

the paths of correct, fast motions are different from slow motions.[22] Their minutely timed, slow-motion pictures preserve the form of these correct motions. Why seek to justify a continuing of slow motions in any capable beginner? If you agree that correct motions should be taught from the start and that these can be clearly demonstrated, what happens to slow typing motions? Wouldn't you push them out of the typewriting-class picture as fast as a first impulse might be to put them in? Of course, your speed should be as near as is reasonably possible to that of the expert. Naturally, to meet variables in yourself, correct motions are taught ahead of fast line rates. Practice fast motions fitted together at your best rate, without forcing. *Work rapidly, regardless of much worthless work at first; let accuracy seem to go by the board.*[23]

The entire learning period serves for conditioning you to minimal action.[24] As your best rate sooner or later becomes a fast rate on common words, as the overlapping between your successive motions grows so short and delicately timed that you can no longer follow this automatic timing, you will likewise find that the order within these common words is both automatic and accurate. Each familiar word is typed entire without a thought and with a new ease. The extinction of your errors also is more or less automatic because, in typing studies, elimination of needless, interfering action goes on until no more elimination is possible. Fast, steady speeds require the least possible action. Learning to be a fast typist is learning to expend minimal time and energy in typewriting. The least possible action implies dropping practically all errors. Eventually, right motions at the right speed will produce the essential accuracy.[25] The general formula to be followed in the acquisition of skills may be summarized as technique (efficient motions) first, fluency (speed or fast motions) second, and accuracy (precise motions) third.

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[22] *Op. cit.*, pp. 119–120.

[23] Gilbreth, F. B. and Gilbreth, L. M., *op. cit.*, p. 121.

[24] Humphrey, G., "Learning and the Living System," *Psychological Review* (1930), Vol. XXXVII, pp. 497–510.

[25] Gilbreth, F. B. and Gilbreth, L. M., *op. cit.*, p. 120.

INTERPRETATIVE SUMMARY

The study of correct motions is here continued from the point of view of speed. A queer bias for petty accuracy hinders uncounted typing classes. "Copy" rather than "technique" is wrongly made the objective. Such slow-but-sure repetition has nothing to do with successful typewriting and is even less accurate. Fast, correct stroking is not mastered in slow practice. The correct motions of the expert, in fact, cannot be made slowly. The slow finding motions used to discover the keyboard are not typing motions. Such awkward motions disappear. A two-letter sequence is virtually the shortest stroking unit in typewriting. Two-letter stroking is both faster and more accurate than single-finger stroking. Growth in rates of speed follows development of this overlapping between strokes. Soon the student's own optimal rate becomes a valued personal discovery. At this pace, which must rise with higher levels of progress, motions appear most normal.

The Gilbreths are fully justified in their stress on correct motions first, speed second, accuracy last. Losses in accuracy with greater speed are relatively slight, unless the speed waxes excessive. Any errors slow up the speed, as the usual error is a transitory breakup in the sequence pace. There is no known relation between faster or slower time and more or less errors. In fact, a drift towards lightening the error penalties for students is already evident. A high quality of work is possible without insisting on high accuracy constantly throughout the learning. Often insistence on other features of technique is better. Spending vast amounts of time on accuracy, interspersed with unpleasantness, seems wastefully slow and does not pay for itself even in accuracy returns.

CHAPTER XII

DISCOVERIES ABOUT TIMING AND RHYTHM

* * *

READING SUGGESTIONS

To the Student Typist: Study what rhythm is, pages 303 to 305, 307 to 314, and 335 to 337. Read to understand what is meant by *initial delay* before a motion, and why, in a rate slow enough, you can prepare each fast motion and keep it fast, pages 314 to 316. Read about practice at regular rates, pages 315 to 318. Think twice about rhythm drills with music, pages 318 to 323. Read to find out why perfect rhythm is a delusion, pages 323 to 334. Notice how to compensate for natural ups and downs in your pace, pages 326 and 327. Read to appreciate, likewise, how irregular the timing for capitalizing or throwing the carriage or other manipulating will become if neglected, pages 327 to 332. Does this explain why your typing is so different from that of classmates, pages 333 and 334?

To the Psychology Student: Read the description of rhythm, pages 303 to 305 and 307 to 314, including basic body rhythms, page 320. Review the influence of music upon motions, pages 318 to 323. Catch the importance of *initial delay* in learning motions, pages 307 to 311. Observe how rhythm then lends a framework for conditioning to definite delay, page 312. This is applied to typing, pages 312 to 316. Incidentally, notice how the optimal rate becomes a handicap, pages 333 and 334. Notice in passing how surprising individual differences arise from irregular timing of separate typing operations, in the curves, pages 323 to 327, and in the Butsch data, pages 327 to 334.

To the Typing Instructor: Several pages sum up the preliminary compromise with slow, finding motions during introduction to the keyboard, pages 305 to 307. The chapter then explains rhythm, pages 307 to 314, 335 to 337. Brief mention is made of short, widely separated rhythm drills, pages 323 to 326 and 332. Cautions for rhythm drills to music are related, pages 318 to 323. Preparing for each fast motion by initial delay, in slow rates of practice, is stressed, pages 305 to 307. Practice at different regular rates is illustrated by machine dictation, pages 315 and 316, and rhythmic commands, pages 316 to 318. Note how a student's optimal rate can become a barrier, page 334. Interference from premature transcribing or office typing jobs is deplored, pages 312 to 314.

At more advanced levels, fast, flexible, individual rhythms are developed, page 335. An account follows of surprising irregularities in timing common digraphs, pages 323 to 326; of protecting the pace against them, page 326; and also of like irregularities in spacing, capitalizing, and returning the carriage, pages 327 to 332. Notice the wide individual differences that result in students under the same instructor, pages 333 and 334.

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NEW ATTITUDE TOWARD SPEED AND RHYTHM

There is a certain absurdity in this separate consideration of correct motions and speed and rhythm. The desired typing outputs do not follow separately from correct patterns of movement of a speedy pace or an optimal timing of this pace. All interact, and any description that tears them apart is highly artificial. Correct motions are also fast motions closely timed with rhythm maintained. You may benefit from slowed moving pictures or quicken your typing speed or invent a new rhythm, but the problem does not change. Your task is still clear-cut — to supply adequate motions. It is the handicap of written English strung out in running lines like strings of beads that forces this piecemeal account, section by section, of the form and timing of motions patterned as wholes.

1. *Gilbreth motion-study notes: speed and rhythm.* The string-of-beads treatment is of course avoided in slowed motion-study films of typewriting, even as it necessarily reappears in running stenographic reports. In a very few lines from the Gilbreth motion studies, however, you will catch the stress accorded to rhythm.

Mr. Gilbreth. I am going to ask you to do something that you have never done before in your life. I want you to write your full name three times, one right after the other. . . . Now I want you to write your full name three times, but I want you to write it leaving out every other letter. . . . That is the first time I have ever seen it done without any errors.

Speed Typist. What I did was to say my name with the stress on every other letter.

Mrs. Gilbreth. It is her sense of rhythm again.

Speed Coach. We should teach the student to use more of a legato.

Mrs. Gilbreth. How much should a student rest between strokes?

Speed Coach. We try to have them make a perfect rhythm.

Mrs. Gilbreth. Then it is not insistence on speed but on rhythm?

Speed Coach. Yes. Speed is not mentioned.

Mrs. Gilbreth. Would you mind if they struck the wrong letters?

Speed Coach. Yes. But we would not stand for incorrect rhythm in a student. My teacher insisted on a rhythm drill. We had to write at exactly the same speed every morning. He was interested in speed work. Many schools do not know how to go after results. He was progressive, that is all.

Mr. Gilbreth. The part rhythm plays is very important. This girl has her speed through scientific analysis of the rhythm of motion. She is not merely quick. She started in for speed from the beginning.

2. *Seeking a useful compromise.* The modern sacrifice of immediate accuracy during early practice with a typewriter is only seeming. Correct motions at fast speeds automatically bring a superior accuracy later when, as a practical typist, quality really counts for you. Accordingly, during your early apprenticeship, you have been cautioned to follow expert motion paths. Yet, if you are a beginner, you are unable to supply expert speeds from the start. Certain compromises or even sacrifices are inevitable. Exactly what is to be sacrificed? Hitherto, after the fashion of the Middle Ages, as Gilbreth[1] cuttingly has observed, the weight of tradition has sacrificed correct motions. The accuracy of the written line has been glorified. This forced perfection of copy at the start of practice would now appear as pseudo accuracy for which the future penalties would be severe. An unjust burden of compromise would also be thrown upon you. At some uncertain date you would be expected to break your incorrect, slow motions and typewrite swiftly. The simile is that of hitching horses to an electric express or oxen to a modern tractor. At least such transport would continue, accurately though clumsily! New times should bring new compromises working toward precision and speed. During the past half century American history has written the story of typewriting as a line of definite increases in timesaving. Despite earlier

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[1] Gilbreth, F. B., *Motion Study* (D. Van Nostrand Company, 1911), p. 98.

days, when experts were afraid to use "weak" little and ring fingers, all-finger typing has arrived. In competition the touch typist has buried the sight typist with his "eyefuls" of copy under avalanches of words counted by the thousand. Visible writing, pressure printing with light, staccato touches, new ways of leaving common words automatic, and new ways of carrying motions along in smooth rhythm have added increase to increase of saving in time. Fast typing today is far faster than it was only yesterday. Still higher speeds are on the way. How can you best compromise with untrained motions in order to participate in this continued advance?

PRELIMINARY COMPROMISE: SLOW FINDING MOTIONS

1. *Mastering keyboard locations.* At the start of your first typing class, you will not even pretend to be typewriting. Perhaps it is the fourth day, and you are writing a short sentence. Yet your motions do not even approach the correct, fast motions of typing. This preliminary compromise over fast motions is sharply drawn by Crooks.[2] You are simply discovering the typewriter keyboard by slow finding motions. You are learning spatial patterns into which to fit later typing. Strictly speaking, you are not learning letter keys but rather the reaches between digraphs. At the very least a single letter key, such as *f*, is stroked *ff*. Preferably, it is stroked where it belongs in a *word*. Time is not wasted on the alphabet as it is, but is spent on such digraphs as *de*, *ki*, *fr*, *sw*, for example, to an extent sufficient to fix their direction from the home row. It might interest you to scan a list of all important digraphs used in typewriting.[3] You may well feel cautious about practicing even digraphs. You should be learning to typewrite *had*, for example, not the common digraph *ad*.[4] You should also be starting to make words automatic in very short sentences that slowly lengthen. If you should happen to be so unfortunate as

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[2] Crooks, M., *Touch Typewriting for Teachers* (Sir Isaac Pitman and Sons, 1931), pp. 35, 47, 53–54.

[3] See list of commonly used digraphs, p. 325.

[4] George, G. C., "Typing Plateaus," *Journal of Business Education*, Vol. VII, pp. 17–18, 1932.

to enter a typing class that still stresses everlasting drills on isolated letter keys, you may well worry. The more thoroughly you learn these isolated letter strokes, the more thoroughly you may be handicapped for your typing life. You are headed, warns George,[5] for "plateau blues" later. His important statement hints further that out-and-out keyboard drills perhaps belong only in advanced, semi-expert typewriting. Then some special reason might be found to justify such drill. During the immediate present, naturally, you need not worry whether or not you look at the keyboard, as long as you are typing from dictation rather than from actual copy. In fact, you can start work on the keyboard by first pushing the carriage over so that the keys do not print. Then you can focus to your heart's content on keyboard directions in common words and simple sentences with no anxiety about the appearance of the then unimportant typescript.

2. *Discarding incorrect finding motions.* Throughout this early keyboard period, in terms of conditioning, you make no attempt to reinforce the signals for these slow finding motions. Notably your own language signals spoken to yourself in silent conversation deal with the positions and reaches of digraphs. This definite set is achieved by a simple device. Before you launch this practice on the keyboard, a correct, fast stroke is demonstrated to you and by you.[6] You learn quickly to "feel" the difference between a light staccato touch and a slow push stroke. You grow interested in a fast "getaway" and play to position the next stroke. Throughout you remain dissatisfied with slow and incorrect finding motions. You want to free your fingers from the restrictions such motions impose, particularly the unnecessary tensions in companion fingers, hand, and arm. In order to rid yourself of these accompaniments, you discover partial relaxation while you are finding the digraphs on the keyboard. The final outcome of this preliminary period is twofold: you establish the keyboard as a spatial frame and you free your fingers for future fast stroking within this frame-

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[5] George, G. C., "Typing Plateaus," *Journal of Business Education*, Vol. VII, pp. 17–18, 1932.

[6] Crooks, *op. cit.*, p. 56.

work. In the end your fingers are no longer glued to guide keys, but hover lightly above them. This early mastery of the keyboard is more a mental than a manual ability. From it is also derived a self-confident attitude. You attack new words with less and less hesitancy.

The duration of this preliminary apprenticeship to the keyboard varies with each typing class and with each student. One approximation seems as good as another. Crooks[7] suggests that you will have absorbed the keyboard relationships whenever your slow finding motions achieve some 20 words in a minute.

INITIAL COMPROMISE: SLOW RHYTHMIC PATTERNS

1. *Fast motions within a slow rhythmic pattern.* Now that you are ready to practice typewriting, your definite task is to develop for yourself correct, fast stroking. A second compromise with speed, however, is still essential. This is made with the aid of rhythm.[8] There seems to be much confusion about rhythm and speed in the typewriting field. As a result, the feasibility of *fast* motions within a *slow* rhythmic pattern is often missed. This is achieved by definite delays in the timing. The essential compromise lies in an unavoidable delay, during which you swiftly plan the correct, fast stroke immediately to come or prepare the "motion feel" of the new word. A fast stroke, though aided by faster rates, does not depend on a fast typing pace.

2. *What is typing rhythm?* Now that you have mastered the keyboard locations and are prepared to discover correct, fast stroking for yourself, rhythm becomes a matter for keen concern. What is rhythm? Hold back a chuckle, for the answer can be a quite curious, unexpected "Believe It or Not." Actually, rhythm is correct typewriting. To describe rhythm, you virtually have to picture a succession of correct key strokes or its equivalent. As soon as you follow Stetson's[9–10] account of rhythm, you will be convinced that this is the fact.

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[7] Crooks, *ibid.*, p. 23.

[8] See Crooks, *ibid.*, p. 86.

[9] Stetson, R. B., "Rhythm and Rhyme," *Monograph Supplements*, Vol. IV, (Psychological Review Company, 1903), pp. 453–466.

[10] Stetson, R. B., "A Motor Theory of Rhythm and Discrete Sensation," *Psychological Review*, Vol. XII (1905), pp. 250–270, 293–350.

Rhythm, at bottom, is an organized group of movements with your muscular tensions maintained. For a satisfactory rhythm, opposing muscle sets are needed. Thus, the flexor muscles of your finger deliver the blow. This produces the beat so characteristic of all rhythm. This initial throw by your flexor muscles is the cue for their relaxation and for your opposing extensor muscles to take hold. As the flexors relax, your finger is caught by the extensors, retarded, then thrown back in an elastic but slower rebound. This rebound is slower despite your best effort. At the finish of the rebound both opposing sets of muscles are tense, holding your finger poised in position.

As the finger delivers its blow, the sharp tension felt between the opposing sets of muscles is immediately followed by retarding and relaxing. This is the chief clue to rhythm. Raise your index finger and beat a rhythm entirely in the air. Isn't the sharp tension between the two opposing sets quite apparent? Both the faster beat stroke so soon relaxed and the slower return give rhythm its direction. So long as the tensions are maintained in a succession of sudden beats and partial relaxing, you have rhythm. The opposing sets of muscles throw your fingers back and forth, like battledore and shuttlecock, with tensions maintained until the end. If tension between the two opposing sets of muscles dies out your rhythm is destroyed by hesitations and jerky stroking.

It is interesting to notice that you lose control as you release the blow and the finger flies down. You regain control of the getaway that brings the finger back to a poised position. Naturally, this interplay between opposing muscles is self-regulating. If the blow is rapid and light, for example, your felt tenseness would be very vague and easily mislocated. A heavy blow, however, would take longer to relax its higher tension. You control the tempo of the rhythm by hastening or slowing the relaxation in the opposing finger muscles.

You have just read a brief sketch of Stetson's account of rhythm. Are you ready to agree that rhythm is made by your stroking of word sequences? Indeed, without such movements rhythm would be pointless. The intervention of the keys does not change your motions or rhythm.[11] The rhythmic tensions are maintained until relaxed, somewhat slowed at the end of the line for the carriage return, and cease only when typing ceases. The unity of these successive line rhythms can be felt. With practice, not only the carriage return but all other "touch" manipulation is caught up in your rhythmic pattern.

The belief is often held that regularity is necessary for rhythm. On the contrary, a movement may be perfectly regular, uniform, and recurrent, yet not give the impression of rhythm.[12] It lacks the sudden snap, then slower relaxing, as pictured above. Your stroking may lag without destroying the rhythm. In fact, your irregularities may be very wide without destroying the rhythm. If the variations in time for different letter combinations do not break the series of tensions, the sequences are felt to be alike. This is why rhythm is still felt, though actually the times for various words differ widely. The belief is sometimes held that rhythm is a matter of judging the time intervals. On the contrary, Stetson and Tuthill[13] show that even professional musicians are unable to achieve absolute time divisions. Rhythm is more a matter of precise muscular tensions.

The use of rhythm in routine activity of the business office or of personal affairs is a noteworthy achievement of fast typewriting. What is rhythm to the management engineer? Rhythm in typewriting, suggests Leffingwell,[14] is moving rapidly, though quietly, while seeming to exert no apparent effort. Rhythm does popularly sum up essentials in successful typewriting. How could it be anything less? If this is rhythm, then any uncertain doubts are clearly not over rhythm *per se*, but over its manner of reinforcement. You may dislike, for example, to follow an enforced common pace faster or slower than your best rate. You may prefer to feel the desired rhythm by listening to copy dictated rhythmically, then typing in this rhythmic pattern. You may want to reinforce rhythm by counting, but not by music. When you typewrite to "counting" or to the tap of an ordinary ruler, for instance, you maintain your rhythmic tensions in fairly regular, continuous succession. You may prefer the automatic ticking of a dictating machine or the electric pacemaker devised by Dvorak. You soon find that such regular typing takes on increasing smoothness, to which the musical term "legato" is happily applied by Margaret B. Owen. The rhythmic successions of your word-and-phrase sequences now progress with the fluent ease of "legato." All such useful words as *continuity*, *facility*, and *fluency* increasingly describe this better typing. *Fluency*, for instance, is rhythm smoothly maintained.

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[11] Stetson, R. B., " A Motor Theory of Rhythm and Discrete Sensation," *op. cit.*

[12] Stetson, R. B., *ibid.* and " Rhythm and Rhyme," *op. cit.*

[13] Stetson, R. B. and Tuthill, T. E., "Measurements of Rhythmic Unit Groups at Different Tempos," *Psychological Monographs*, Vol. XXXII, No. 3, pp. 41–51.

[14] Leffingwell, W. H., "Training Clerical Workers on the Job," *Handbook of Business Administration*, W. J. Donald, Editor (McGraw-Hill Book Company, 1931), p. 812.

3. *Avoiding an excess of rhythm drills.* If typing improvement rests on your discovery of improved rhythmic patterns, what about rhythm in your practice? Is your typewriting class to resolve into an endless succession of rhythm drills? How boresome to entertain such a notion! How depressing is such a vista! Avoid any excessive use of rhythm drills as such. The only efficient drills are short and lively and widely separated. Indeed, the most successful drills you will want to work up yourself in following out some keen interest in a new, definite bit of typing.[15] The tiresome, conventional drill is mere repetition. You are not interested in such repetition. The tiresome monotony of conventional drills went into a decline with the demise of the so-called "law" of learning by repetition or mere exercise. The amount of repetition by drill is of little consequence. It is the stimulation from a drill that counts. By stimulation is meant the sudden shifting of conditioning signals. You are interested in catching a *rhythmic pattern*. You are interested in holding this rhythmic pattern by reinforcement of its signals. Probably more practice on relaxation and fewer formal rhythm drills will suffice.

4. *Timing of definite delays in typing sequences.* It is the definite timing of your succession of key strokes that permits definite delays

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[15] Blackstone, E. G., "The Supervision of Commercial Education," *The Supervision of Secondary Subjects*, W. L. Uhl, Editor (D. Appleton-Century Company, Inc., 1929), pp. 358, 369.

in which to organize a correct, fast stroke. Each unavoidable pause required by the typist beginner to approximate a correct stroke can be reinforced by counting or listening. This counting is merely an added device, to be dropped whenever unnecessary. With or without counting, some regular delay is unavoidable if you are to try for a correct, fast stroke from the very start.[16] No key stroke is isolated, but is always kept in its sequence. It is incomplete and incorrect unless in sequence. Counting marks off just enough delay and helps fit each key stroke into this definitely timed series.

The sacrifices resulting from these delays which prepare the motion lie chiefly in the fingers' slower *plays for position* and the weak *overlapping* of strokes in sequence. Such sacrifices, however, seem inevitable while you are a beginner typist. Such hesitations appear inevitable also prior to mastery of a fast pace. By regular, continuous dictation or counting or other timing device, any hesitations are brought under control. Your rhythmic typing pattern is thus fitted at first to a quite slow yet regular pace in which pauses before correct, fast stroking are tolerated within definite limits. Though tolerated, these delays in which you construct the motions are discouraged and are gradually eliminated by shortening the pauses. No typist beginner should consider a pause as such. If you even think "pause," for example, you are quite sure to exaggerate your delay and just hang suspended in hesitation. Perversely enough, many an ordinary student typist seems to enjoy this. In terms of your action, each *pause* is simply this: thinking of the next stroke while stroking the first. During each initial delay you construct a pattern for the next stroke.[17] As you think only of your stroking, you need not feel the pause. In fact, the latter is shortened more and more as your practice moves forward. As practice progresses, the slow rhythmic successions become increasingly faster through faster pacing. This is termed "practice at different rates."

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[16] See Gilbreth, F. B. and Gilbreth, L. M., *Applied Motion Study* (The Macmillan Company, 1919), pp. 109–120.

[17] Wheeler, R. H. and Perkins, F. T., *Principles of Mental Development* (Thomas Y. Crowell Company, 1932), p. 262.

5. *Lack of rhythm in inefficient typewriting.* What happens if you are allowed to hesitate over correct stroking outside of any slow rhythmic pattern? A series of hesitations runs wild throughout your practice. These hesitations cannot be eliminated because there is no way of bringing them under control. There is no way of fitting them into a quite regular, continuous pattern for which the simile is a reasonably smooth musical "legato." The jerky, irregular succession of your unpaced strokes is the opposite of rhythm. Leffingwell[18] finds such series of hesitations still running through all the operations of inefficient office workers.

6. *Rhythm as a pattern for correct conditioning to definite delays.* If disturbing interference is kept away during this initial compromise stage, you are pointed for future freedom by occasionally holding an even, class-group rate that permits just enough delay between the strokes. Rhythm requires that the succession of tensions be maintained. A simple, fairly regular succession provides a pattern of correct delays for conditioning. It permits two desirable results by automatic conditioning. First, your every stroke is conditioned to definite delays. Second, each unavoidable delay or pause is gradually shortened as the correct stroke creeps forward toward its conditioning signals. These definite delays automatically grow shorter and shorter. Gradually the stroke is conditioned to a definite, least possible delay. Correct timing and correct overlapping become automatic. During this entire compromised practice stretch these essentials take precedence. First and foremost is correct, fast stroking. Any conditioning for incorrect motions must be discarded later as wasted. Supplementing this is a well-defined, slower rhythmic pace that embraces the unavoidable delays between fast strokes. All this increasingly invites your relaxed following of copy sequences.

7. *Avoiding interference from premature transcribing, special page arrangements, excessive reading from copy, special mechanical devices.* The right of way in your practice belongs to your stroking. Avoidable interference is taboo. As far as possible, you are not to be distracted. Not infrequently, for example, disturbing interference

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[18] *Op. cit.*

arises in overearly attempts at transcribing shorthand notes. Weersing[19] mentions such attempts in Typewriting I although students are typing only 15 to 20 words a minute! Even typing rates above 40 words can be cut in half by the need for transcribing. At the opposite pole, of course, would be neglect of transcribing throughout the entire typewriting course. You may be interested to know that only 14 teachers among 160 have failed to provide regular transcription practice in Typewriting II. Fully one fourth, however, have not drilled for speed in this transcription. In New Jersey you would find the usual student transcribing only 18 words a minute after three terms.[20] Typing from shorthand notes ceases to interfere whenever the shorthand reading is facile and the typing reasonably automatic. Whatever earthly reason is there to unite these two any sooner? If a student has a working mastery of his typewriting, transcription may be rapidly included. Easy transitions from copy without capitals, punctuation, or paragraphing, through printed shorthand plates, to easy shorthand copy are applied.[21] These simple precautions are carefully reviewed by Crooks.[22] Dictatypy or stenotypy seems less apt to cause interference. You would be more likely to read stenotypy or dictatypy easily, since it is acquired more quickly. The eyes are little used except for the transcribing. This would leave you more rested than would pencil shorthand writing.

Whenever convenient, use of direct dictation or of transcribing machines removes any early interference from copy. In either event, the early introduction of correspondence forms and page layouts in manuals might well be delayed, as they cause much interference and hesitation. To avoid interference with this gradual mastery of correct stroking, Crooks[23] would go so far as to transfer instruction in the mechanism and care of the machine as a whole, page display, and tabulation, up to a more advanced stage. If you should agree, then you would be faced at once with the pressure of vocational needs for the day's work in the office world. Whatever the compromise, advanced typing can be more easily and wholeheartedly devoted to realistic typing jobs borrowed from business and industrial offices.

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[19] Weersing, F. J., *Reorganization of Commercial Education in Public High Schools* (South-Western Publishing Company, 1929), p. 37.

[20] Rice, L. A., "Shorthand Transcription Survey in New Jersey" (Abstract), *American Shorthand Teacher*, Vol. IX (1929), pp. 179–180.

[21] Reigner, C. G., "Transcribing Letters," *Applied Typing* (H. M. Rowe Company, 1927), Part II, pp. 48–59.

[22] See Crooks, M., *op. cit.*, "Correlation of Shorthand and Typewriting," pp. 166–172.

[23] See Crooks, M., *ibid.*, pp. 23–24.

8. *Avoiding interference: Iowa personal-typewriting classes.* Clever handling, however, may turn many of these seeming distractions into helps. Blackstone[24] tells of single-semester personal-typewriting classes successful with letter writing and envelope addressing and the ability to erase and correct, proofread, tabulate, rule, and manipulate the parts of the machine. The Blackstone test score for such a college class was 103, or 15 points above the usual high-school typewriting class; for a similar junior high-school class it was 91, or 3 points higher. The secret of such success seems to lie in the practice in its natural setting of typewriting as a whole. The point is also taken that general rules may thus be broken at right times in correct ways.

9. *Correct stroking first, timing second.* The value of continued emphasis by you and other students on rhythm is seriously questioned by Entwisle.[25] Rhythm has been stressed all through the first semester of three typing classes in the Lead High School (South Dakota). There has been no mention of rhythm in three control classes. While the test scores seem mostly nip and tuck, Entwisle reports the nonrhythm groups slightly ahead on average semester scores. This slight lead is more apparent in twelve pairs of beginning students.

This suggestive result is weakened by vagueness as to just what was done in the way of rhythm. Rhythm is defined as "giving to each letter stroke an even-flowing touch, so that each key required approximately the same amount of time as is given to the other strokes." This notion of rhythm hardly fits. In fact, a motion that is "even flowing" throughout is not rhythmic. Rhythm requires the staccato blow, immediately retarded and relaxing up from the key. In this experiment it almost seems as if a correct, fast stroke was sacrificed to a regular, monotonous counting of each stroke. "Rhythm" seems relegated by Entwisle to a regular time allotted each key stroke. This is the usual oversimplification of stroking as the tapping of isolated letters. Such absolute regularity for each key stroke is not possible on the common keyboard. The rhythmic unit is a sequence in which the times of separate strokes may vary widely without destroying the rhythm. It is this succession of serial strokes, in fact, that should have been felt as "even flowing." Entwisle holds that strokes to favorably placed keys are delayed to the point of lost accuracy in order to equal the slow pace of the more distant reaches, especially for the weaker fingers. This is another way of saying that a rhythmic pattern remains unnecessarily difficult with the awkward "universal" keyboard. In your own practice, however, after mastering the total keyboard arrangement, have you found the unevenness really so pronounced in slow rhythm, well under 40 words a minute? Isn't there an impression from this experiment that "rhythm" has been used as a distraction that has handicapped both keyboard mastery and discovery of correct stroking?

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[24] Blackstone, E. G., "A Proposed Battery Test for Typewriting," Monographs in Education, *Research Studies in Commercial Education,* Vol. IV, First Series, No. 11 (University of Iowa, 1929), pp. 14–17.

[25] Entwisle, B. S., "An Experiment with Rhythm in Teaching Typewriting," Monographs in Education, *Research Studies in Commercial Education,* Vol. II, First Series, No. 8 (University of Iowa, 1928), pp. 75–83.

10. *Practice at different rates illustrated by transcribing machine records.* The very use of gradually increasing rates assumes the prior achievement of a correct stroke. Its speed and rhythm have been realized at the expense only of faster timing in the sequences. In *practice at different rates*, to use a slow stroke at slow rates and a faster stroke at faster rates would waste your time. Such wasteful practice could only mean a misconception. A slow stroke is destructive of rhythm at any rate. In practice at rising rates the light, staccato strokes are maintained while the timing of their sequences is improved. Doesn't it seem that Crooks[26] is correct in urging that rhythm provides you with a scheme of practice? Any sustained, rhythmic pace conditions the word sequences to definite finger delays.

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[26] *Op. cit.*, p. 87.

This is neatly illustrated in the use of dictating or transcribing machines.[27–28] In the first place, the transcribing machine at once decreases the number of variables against which you work.[29] The laborious following of copy no longer distracts. In the second place, the careful speeds of machine dictation give a regular timing at rates anywhere from 10 words to 60 words per minute. This steady pace provides the necessary pattern of correct delay for conditioning. The pace is gradually advanced whether you type alone or in unison with the class at a rate of from 20 words to 40 words a minute or beyond. Moreover, your class may be broken into natural groups practicing in differing timings. In fact, with individual earphones and voice writing, or paired to alternate the dictation with another student, you may have a wide choice of available rates. Thus, if you should have trouble typing 20 words a minute, Pearson [30] might give you a record at 25 words a minute. Then, when put back, you could write the 20-word record with unexpected ease. You observe that this treatment is very different from a warning to "slow down." Correct stroking is thus maintained and fitted into correct timing. In this manner, your fast typing of common words is gradually perfected, with all the mechanical advantages that automatically accrue. If your typing thus ceases to be a more or less slapdash affair, control of practice at different rates will have assumed its rightful place.

11. *Electrical Pacing.*[31] Recently the Carnegie Corporation of New York through the Carnegie Foundation for the Advancement of Teaching assigned the University of Washington two substantial grants of money for research in timesaving in the teaching and learning of typewriting. Experimental classes in 1933 and 1934 made

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[27] See also Marshall, C. H., *Manual of Talking Machine Dictation and Transcription* (Gregg Publishing Company, 1932).

[28] See also Miller, C., *Miller Dictaphone System of Typewriting* (Miller Textbook Company, 1932).

[29] Gilbreth, F. B. and Gilbreth, L. M., *Motion Study for the Handicapped* (George Routledge and Sons, 1920), p. 48.

[30] Pearson, D. C., "An Experiment with the Miller Dictaphone Method of Teaching Typewriting," Monographs in Education, *Research Studies in Commercial Education*, First Series, No. 7 (University of Iowa, 1926), pp. 77–87.

[31] Dvorak, August, "Developing Rhythm in Typewriting," *Journal of Business Education*, February, 1935.

possible by the first grant included a total of 1881 students. In order to teach that number of students successfully under experimental conditions, the problem of developing rhythm efficiently was studied. Under the conditions imposed by the large number of students in the experiment, any device or technique, to be acceptable, had to meet the following requirements:

1. It must not be expensive.
2. It must be easy to operate.
3. It must be capable of easy adjustment so as to provide a wide range of rates by small succeeding steps or levels.
4. It must be definitely calibrated so that it can be set and started at any desired rate without delay and be capable of easy and definite changes in rate while a class is in session.
5. It must operate at a constant unchanging rate when started.
6. It must be loud enough to be heard when a class is typing.
7. It must not be so loud or sonorous as to be annoying or distracting.
8. It must be self-operating so as to leave the teacher free for individual instruction and to help students in difficulties.
9. It should permit groups of students to type at different rates, allowing for different rates of student progress.

The limitations of the usual techniques and devices stimulated Dvorak to develop an electrically operated *Type-Pacer** which satisfied eight of the requirements in full and partly satisfied the ninth. The *Type-Pacer* has as its basis a small geared electric motor which runs at a constant speed. The motor by means of a small leather belt runs a disk which in turn causes a small hammer to strike an appropriate sounding board. By a simple arrangement the rate at which the hammer strikes the sounding board can be varied to produce even rhythmic tapping at rates corresponding to 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, and 75 words per minute. The motor cord is plugged into any 110-volt alternating-current or direct-current wall or lamp plug. A switch on the motor permits the motor to be started and stopped at will. A pointer on a scale indicates the rhythm rate for which the *Type-Pacer* is set. To change to slower or faster rates, the pointer is moved to the right or to the left to the desired point on the scale. The rate can be changed both when the motor is stopped or when it is running. This permits the teacher gradually to slow down or to increase the rate while the class is typing.

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*See Figure 17, p. 319.

The sound produced had to be sufficiently loud for a typewriting classroom, pleasant, and of short duration. The vibrations of metallic bells, while loud and pleasant to the ear, tend to linger so as to produce a continuous ringing. Various woods were tried and found inadequate. A Bakelite sounding board finally solved the problem.

Using the *Type-Pacer*, the teacher decides on the rate at which students are to type, sets the pointer to the desired number on the scale, starts the motor, and is then absolutely free to supervise individually every pupil in the typing room. If she stops to talk to a student or to a visitor, the *Type-Pacer* does not stop, but keeps beating at a smooth, even, pleasant-sounding, rhythmic rate.

12. *Limitations of musical rhythms in typing practice.* In reinforcing a regular typing rhythm, do you already experience a fresh release from routine as music brightens some steady rhythmic pattern? Undoubtedly you are well aware of the enlivening sparkle and vim caught up in American radio, musical comedies, and band marches by Sousa. Until music grows familiar, indeed, a lively tune can be too enlivening in its own right. Shall musical records parade your typing class, much as a crack college band parades the football field? There is a double influence in music because of musical tones even more than because of rhythm. Perhaps this illustration catches your interest: sorting mail to music in a United States post office has reduced errors 12% and has noticeably speeded the work. If you follow Diserens,[32] pleasant musical sounds add force to the action of your muscles, but the rhythm merely reinforces regularity in your motions. Diserens[33] has compared the typing of ten fairly skilled touch typists on uninteresting business prose about banking. A fast, stirring march has failed to increase

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[32] Diserens, C. M., *The Influence of Music on Behavior* (Princeton University Press, 1926), p. 122.

[33] *Ibid.*, pp. 166–169.

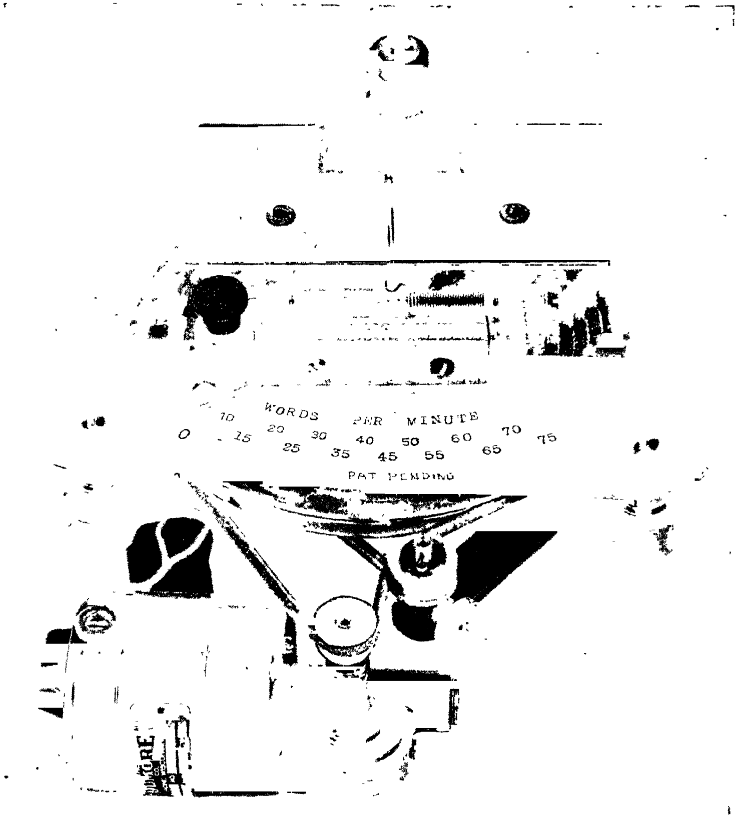
WORDS PER MINUTE
0
10
15
20
25
30
35
40
45
50
55
60
65
70
75
PAT PENDING

Figure 17. Electric Type-Pacer
(Reproduced through the courtesy of Torka Bros., manufacturers)

the speed, but errors have risen from 4% to nearly 6%. Slower music of the *Meditation* from Thaïs, however, has speeded the strokes from 439 to 477, or 8%. Consider handwriting practice. Music has served as a mild distraction, to increase the size of handwriting.[34] Consider practice of aiming movements. Music has had little effect on precision of aiming and could be distracting.[35] Consider practice in drawing straight lines. Music has increased by 8% the length of lines, and by 25% the drawing speed.[36] Yet poorly chosen musical selections can disrupt rather than improve your typing precision. Other music may show only slight effects. Still other music subdues the noisy setting of clicking keys, enlivens the action, and submits the typing to a well-defined rhythm. The simple rhythm so clearly illustrated in all correct stroking of a typewriter, however, is complicated by added rhythms in music. Perhaps you have noticed even in the obvious shuffle dance of an American Negro that different opposing sets of muscles in hands and feet and swaying body are simultaneously beating out different rhythms. The still more complicated, subtle rhythms interwoven at once in much up-to-date music can interfere with typing practice at even rates. Aside from monotony, the simple repetition of primitive music among savages would seem more suited. Isn't it clear that you need to be cautious in your welcome of a musical record turned on for a rhythm drill?

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[34] *Ibid.*, pp. 170–173.

[35] *Ibid.*, pp. 165–166.

Music is a serious distraction if the extremes of jazz or slow dirge music resound in your typing class. Jensen[37] assures you that it

TABLE XXVI

NUMBER OF STROKES AND ERRORS WITH AND WITHOUT JAZZ OR DIRGE MUSIC ON THE PHONOGRAPH

(From Jensen[38])

	Normal Conditions	Jazz Playing	Dirge Playing
Strokes . . .	215	215	209
Errors . . .	.9	1.2	.9
Words . . .	33.6	31.0	32.9
Relationship (r) between Errors and Stroking Speed	− .11 (P. E., .09)	− .19 (P. E., .09)	− .50 (P. E., .08)

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[36] Diserens, C. M., *The Influence of Music on Behavior* (Princeton University Press, 1926), pp. 174–178.

[37] Jensen, M. B., "The Influence of Jazz and Dirge Music upon Speed and Accuracy of Typing," *Journal of Educational Psychology* (1932), Vol. XXIII, pp. 458–462.

[38] *Ibid.*

is safer to avoid such distraction. Observe what has happened in three typing classes of students about 17 years old. After 37 weeks of typewriting, they have first typed to jazz music, such as *Valencia* rendered by the Mayflower Serenaders or the *Bugle-call Blues* played by Jack Pettis and his Pets. Errors have increased noticeably enough to decrease net words per minute more than 7%. At the other extreme, with Fritz Kreisler's playing of slow dirge music, speed has been slowed fully 2%. Under normal room conditions, the relationship between speed of stroking and errors has been only − .11, or very little. Yet with the strains of the dirge this relationship has risen to − .50, which is distinctly noticeable. This is a timely warning against importing syncopated American jazz or sad, classical music in minor keys. All that is essential, as Crooks[39] tells you, is the rhythmic beat in simple forms of familiar waltz and two-step, familiar collegiate or military march music with real musical appeal.[40–43]

Your use of music needs to be widely distributed. This infrequent typing to music lasts not more than ten minutes, or even less, if you follow Crooks.[44] Used to provide occasional cues, musical rhythm becomes a framework into which correct stroking is fitted in closely timed sequences. Into its rhythmic pattern your flexible, lively key strokes are thrown in orderly succession. Control of the timing by the musical record drops each rhythmic imprint into its proper succession. If the steady musical rhythm hurries your pace overmuch or excessively retards it, your seating in a smaller or different group might be arranged. Of course, the rhythmic musical beat hurries the pace of the difficult sequence and retards the pace of an easy, familiar sequence. All this can occur within reasonable limits without destroying the rhythmic pattern. As long as a correct, fast stroke is maintained, this seems highly desirable until control of timing becomes automatic.

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[39] Crooks, Maxwell, *Touch Typewriting for Teachers* (Sir Isaac Pitman and Sons, 1931). For a clear-cut treatment of the use of musical records, read Chapter XIII, "The Use of the Gramophone," pp. 92–100.

[40] *Ibid.*

[41] For a briefer statement, see Maclean, Lola, *Walton-Maclean Typewriting Procedure and Practice* (Walton Publishing Company, 1931), Teachers' Manual, pp. 3–4.

[42] See also Smith, H. H., "A Model Demonstration of 'Typing to Music,'" *American Shorthand Teacher* (1928), Vol. IX, pp. 143–148.

[43] See also Crum, Annabel, "Typing to Music," *American Shorthand Teacher* (1930), Vol. X, pp. 378–380.

[44] *Op. cit.*

13. *Cessation of slow class-group paces.* The duration of this initial compromise stage, centered around correct, fast stroking, varies with your typing class and also with you. One approximation seems as good as another. Your "drive" is not over the top in some systems until your slowed rhythms have increased to a rate of from 40 to 48 words per minute.[45–46] Of course, these are arbitrary rates. Whatever rate is chosen, its pace takes into account the surprising fact that some two-letter sequence times are two or more times faster than others. Consider a very slow sequence, such as *de*, that typically requires the same finger to reach for its second stroke. The expert limits of *de* appear to lie in the neighborhood of 70 words a minute.[47] Doesn't a limiting pace of under 50 words a minute leave an ample play for these slowest sequences? This rate simply signifies a point in the progress at which you at last are stroking with an ease and at the same time a firmness that should free you from further reliance upon the class-group rhythms.

The conditioning has now crept forward until correct, fast strokes are overlapping at some 40 or 50 words a minute. In contrast with expert speeds, this is only a fair rhythmic pace. Throughout all this prior practice, however, the motions have been as like the expert's as it is humanly possible for you to make them. The conditioning to definite delays seems at last to ensure just enough timing between you and the machine. There is no discouraging, stupendous task of "unlearning" slow motions and erratic timing whereby certain key strokes are lost or poorly imprinted or out of place. A correct basis is already laid for the skilled motion cycles of the expert. From this point on, continued writing to an arbitrary count or pacemaker or music might increasingly disrupt the

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[45] See Crooks, *ibid.*, pp. 23, 174.

[46] See Maclean, *op. cit.*, "The Scientific Development of Speed," Teachers' Manual, p. 45.

[47] Coover, J. E., "Principles of Learning in Typewriting," *The Rowe Budget* (1928), Vol. XXX, p. 11.

advanced rhythms of more and more familiar words grouped by entire lines of connected copy. The use of simple class-group rhythms, including simple musical rhythms, can cease. The student typist is freed to follow increasingly his own faster individual rhythms. The way is open to the rising speed and fluency with sequences which mark skilled operation. Rhythm continues basic but flexible.

FLEXIBLE FAST PACES: IRREGULARITIES IN TIMING OF TYPING SKILLS

1. *Irregularities in timing common digraphs.* How flexible fast typing rhythms must be is sharply revealed by timing two-letter combinations known as *digraphs.* The discrepancies between the times required for you to stroke certain digraphs, as compared with other digraphs, are chiefly due to the unavoidable delays which accompany certain spatial arrangements upon the common keyboard. These startling differences in sequence times lend ample support to Coover's[48] view that perfect typing rhythm is a popular delusion. In expert typing around the neighborhood of 130 words a minute, you may recall this psychologist's finding that digraph times vary from the equivalent of 70 words a minute for *de* to 224 words a minute for *nd.* These unavoidable delays on the old keyboard increase as the spatial patterns change from sequences involving fingers of opposite hands (such as *ei, em*) to a sequence using adjacent fingers of the same hand in an outward direction (as *es*) to a sequence across the home-row barrier[49] with a side reach involving fingers of the same hand (as *on*) to a sequence requiring the same finger (as *de*). Another sample of relative times for these digraphs on the "universal" keyboard gives (1) *ei,* 2 time units, (2) *em,* 4 time units, (3) *es,* 5 time units; (4) *on,* 10 time units; (5) *de,* 11 time units.[50] The fastest two-letter sequences naturally are written in

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[48] *Ibid.*

[49] For further discussion of the home row in its relations with other reaches, such as up reach and side reach, see Gardner, E. E., *Better Typewriting* (Prentice-Hall, 1931).

[50] Klockenberg, E. A., *Rationalisierung der Schreibmaschine und ihrer Bedienung* (Julius Springer, 1926), p. 87.

familiar phrases by fingers on opposite hands or at least by remote fingers. In an average speed of 130 words a minute, Coover [51] finds such digraphs can equal 174 "words" a minute. A sample familiar phrase might be: *this is the.* The pace is slowed in varying amounts if the digraph involves adjacent fingers. For example, this slowing is less if the digraph direction is inward from a lesser to a stronger finger, and vice versa. The slowing is greater, for instance, if the digraph is stroked by adjacent fingers on keys separated by the home row. Of digraphs tapped or reached with one and the same finger, the least said the better. Usually these are the poorest sequences in typewriting. Practical present limits of such speeds Coover [52] places at 70 or 85 "words" a minute. Thus, simple tapping with one finger of *jj* Coover times at .28 second; with the second stroke one bank away, as *jm*, at .32 second; and across two banks of keys, as *um*, at .34 second. You find a lively set of attractive names [53] attached to these two-letter sequences. Thus, a "tapping" sequence uses the same finger in successive strokes to the same key, as *ee.* The so-called "reach" sequence uses the same finger in a second stroke to another key, as *ce, de* on the common keyboard.

The "trill" sequence, perhaps after an analogy with a musical trill by adjacent fingers upon the piano, employs an adjacent finger for the second stroke, as *er, se, ve.* The so-called "rock" sequence, perhaps after a likeness to a sort of rocking movement between two overlapping strokes, uses a remote finger for its second stroke, as *ou, ho, on.* The "opposite" sequence gives its second stroke to a finger of the opposite hand, as *ha, th, en.* The most-used two-letter sequences are presented in Table XXVII. (See also Table XLI, page 379.) Upon your own typewriter (unless you are using a revised keyboard) stroke the line of opposite-hand combinations in the same bank. Then for a sharp contrast stroke such "trill" or "reach" sequences as *be, te, ce.* Notice also that the left hand bears an unfair keyboard burden of frequent "trills" and "reaches." But do not tarry over these unusual fingering names.

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[51] Coover, J. E., "A Method of Teaching Typewriting Based on a Psychological Analysis of Expert Typing," *Proceedings* (National Education Association, 1923), pp. 561–567.

[52] *Ibid.*

[53] *Ibid.*

TABLE XXVII

Classification of the 60 Most Important Two-letter Digraphs by Banks and by Hands on the "Universal" Keyboard, with Time in Equivalent Words per Minute of 7 Typical Sequences, Arranged in Order of Importance, with the Most Common Digraphs Italicized [54]

Name	Digraphs		No.	Time of Typical Digraph
Combined Opposite-hand and Remote Fingers in Familiar Phrases				174
Combined Opposite-hand and Remote Fingers . . .				156
Opposite-hand Fingers				
Same bank . . .	*Ha*, *to*, or, it, ur, wi, al, ot, ti, ut, ow			
Adjacent banks .	*th*, *he*, *an*, *nd*, is, of, ng, le, fo, ay, so, ch, us, wh			
2 Banks remote .	en, me, nt, ne, co		30	145
Total digraphs and net speed in words per minute . . .			60	130
	Left Hand	Right Hand		
Remote Fingers ("Rock")				
Same bank . . .		*ou*, *yo*		
Adjacent banks .	at, ar, st, ea, av, ad	ho		
2 Banks remote .		on, no, om	12	122
Adjacent Fingers ("Trill")				
Same bank . . .	*er*, *re*, as, te, we, et			
Adjacent banks .	se, es	hi, il		
2 Banks remote .	ve, be	*in*	13	115
Same Finger ("Tapping")				
Same bank . . .	ee	ll	2	85
Same Finger ("Reach")				
Adjacent banks .	ed, de			
2 Banks remote .	ce		3	70

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[54] *Ibid.*

It suffices to understand that the times for digraphs differ as the keyboard requires up reaches, down reaches, side reaches, hurdles across the home row, or motions involving the same, adjacent, remote, or opposite-hand fingers. It helps to understand how less-effective fingering on the old keyboard needlessly assaults and weakens the rhythm during a fourth of all ordinary typing. Doesn't this clarify for you the necessity for exceptional flexibility in fast typing rhythms and their timing?

2. *Protecting the pace in awkward sequences.* Your study of these common digraphs helps show where the larger possibilities of future speed gains lie. Fully one half are combined even on the common keyboard as opposite-hand sequences, while the new keyboard increases this proportion 40%. By the same token, from your study of serious handicaps in the old keyboard,[55] you already know what kinds of sequences endanger fast rhythms by forcing awkward motions or idling of one hand. You know that these irregularities are unduly wide on that keyboard.

A single warning is given you by Smith: [56] "Protect with unceasing vigilance the natural weakening of pace in such digraphs." Smith compares the more difficult word combinations and their slower digraphs with the hurdles in certain track events, except for the fact that difficult sequences occur at irregular intervals. The sprinter slightly changes pace as he approaches and clears the hurdles. In the same way, as you slow, then pick up speed, there ought to be no sharp break in the pace. By a close measurement of typing motions, Smith [57] is able to show you above and below the general pace a vertical crossing and recrossing of rhythms. Slower rhythms for slower sequences sink below and faster rhythms for faster sequences rise above the underlying rhythm. The term *fluency* is then applied to every successful interweaving of these many rhythms as the onward flow of your typing passes without a break from one rate to another.[58]

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[55] See pp. 209–217.

[56] Smith, H. H. and Wiese, E. G., *Seven Speed Secrets of Expert Typing* (Gregg Publishing Company, 1921), p. 23.

[57] Smith, H. H., "The Teaching of Typewriting," *American Shorthand Teacher* (1930), Vol. X, pp. 222–226.

[58] *Ibid.*

You fit the pace to the sequence. The "simplified" keyboard is designed to reduce this crossing and recrossing of minor rhythms and thus protect your rhythm.

A second warning is given you by the Gilbreths:[59] "Never practice the same sentence too long, lest its digraphs and words be combined beyond the point of fluent use in unfamiliar copy."

A third warning can also be added: The improvement of fast rhythm, or fluency, extends beyond your practice of the common words composed of such widely differing digraphs. All other touch manipulating of your typewriter needs to be caught up in the forward flow of your work.

3. *Ratios between key stroke, space-bar stroke, capital-letter stroke, carriage-throw timings in sequence.* The four most important kinds of motion subcycles in typewriting have been measured.[60] The times of these movements are caught as they occur in regular sequence, not as isolated "strokes." Butsch[61] found the usual time pattern between these various motions, when the average time of a letter stroke in sentence copy is taken as 1, to be 0.8 for the space-bar stroke, 3 for the capital-letter stroke, and 7 for the carriage return. In short, the usual carriage throw takes 7 times as long as the usual key stroke and the capital-letter stroke takes 3 times as long. Both these times seem overlong, while each space-bar stroke should fit the key-stroke timing. Yet here are four sets of speeds, without taking into account how widely several hundred digraphs and larger letter combinations may vary in pace. Each varies with different students, as shown in Figures 18 to 20. No pattern short of flexible rhythm could sustain these many speeds in one fluent motion cycle from paper insertion to paper removal.

In all, 75 typists of all grades have been measured by Butsch.[62] The fastest have actually been 3 times as fast on the letter stroke, 4 times as fast on the space-bar stroke, and 6 times as fast on the carriage return as the slowest.

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[59] Gilbreth, F. B. and Gilbreth, L. M., *Motion Study for the Handicapped* (George Routledge and Sons, 1920), p. 153.

[60] Butsch, R. L. C., "An Experimental Study of Progress in Typewriting," Master's Thesis (University of Chicago, 1927).

[61] *Ibid.*

[62] *Ibid.*

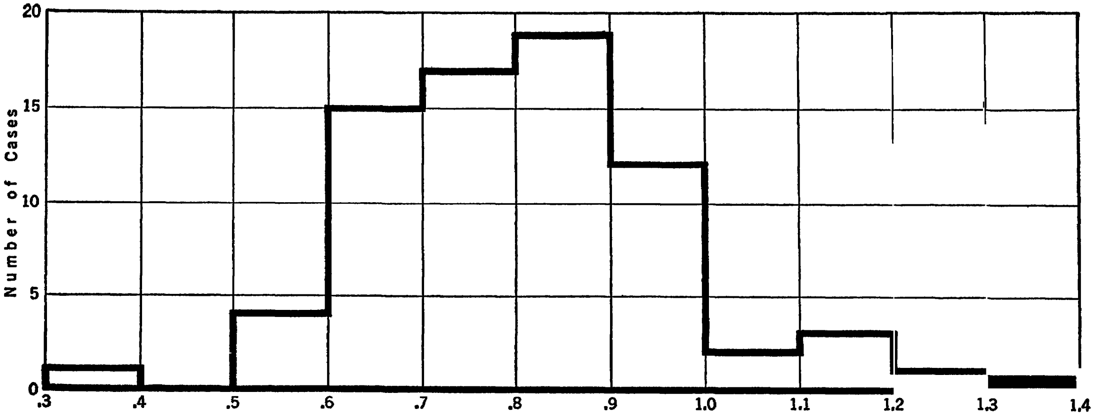

Figure 18. Distribution of Times Required by Student Typists for the Space-bar Stroke, Relative to the Key Strokes[63]

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[63] From Butsch, R. L. C., "An Experimental Study of Progress by Typewriting," Master's Thesis (University of Chicago, 1927).

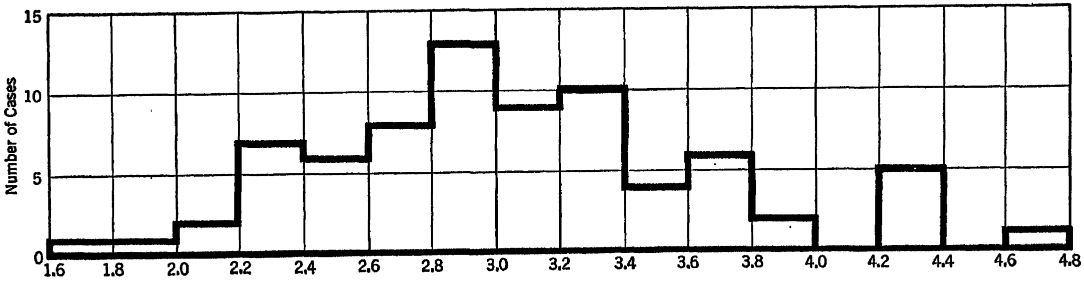

Figure 19. Distribution of Time Required by Student Typists for the Capital-letter Stroke, Relative to the Key Strokes[64]

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[64] From Butsch, R. L. C., "An Experimental Study of Progress by Typewriting," Master's Thesis (University of Chicago, 1927).

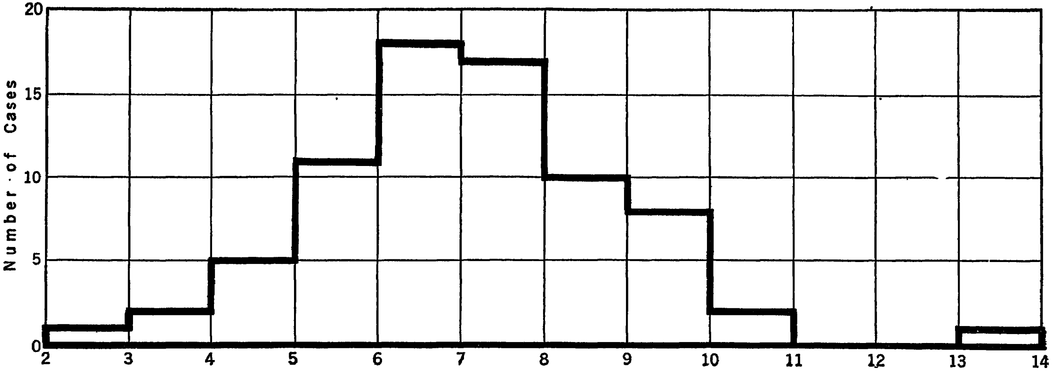

Figure 20. DISTRIBUTION OF TIMES REQUIRED BY STUDENT TYPISTS FOR THE CARRIAGE RETURN[65]

[65] From Butsch, R. L. C., "An Experimental Study of Progress in Typewriting," Master's Thesis (University of Chicago, 1927).

TABLE XXVIII

MEDIAN TIME RATIOS FOR FOUR STROKES, 15 FASTEST AND 15 SLOWEST STUDENTS
(Butsch data [66])

	Letter Stroke		Space Bar	Capital Shift	Carriage Return
	Speed *	Ratio			
Upper 15 . . .	33 mm	1.0	0.88	2.9	7.2
Median . . .	43 mm	1.0	0.80	3.0	7.0
Lower 15 . . .	61 mm	1.0	0.64	2.7	6.3

Unfortunately, the ratios between these four speeds have not improved accordingly but more often have behaved contrarily. Relative speeds are quite another matter. Do you observe in Table XXIX that the relative space-bar rate drops back toward the usual letter-stroke rate? To an extent this is a natural improvement by which spacing is caught up in the typing rhythm. With the faster typists the space-bar stroke now takes up more than four fifths of the time of a letter stroke; with the slower typists, less than two thirds. Observe also in Table XXIX that the carriage return of the slower typists is only 6 times longer than the letter stroke. The relative speed of the space bar and carriage return

TABLE XXIX

RANGE OF TIME RATIOS FOR FOUR STROKES, 15 FASTEST AND 15 SLOWEST STUDENTS
(Butsch data [67])

	Letter Stroke		Space Bar	Capital Shift	Carriage Return
	Speed *	Ratio			
Upper 15 .	27–36 mm	1.0	0.70 — 1.16	2.1 — 4.2	3.4 — 10.6
Lower 15 .	56–90 mm	1.0	0.33 — 1.10	1.9 — 4.7	4.6 — 9.6

* Butsch measured the time of different strokes in millimeters between imprints on paper moving through the typewriter at a uniform rate.

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[66] *Ibid.*

[67] *Ibid.*

with the 15 slowest students is slightly faster than with the 15 fastest students.

Evidently a high speed in typewriting as a whole does not necessarily show the best results with each of the different strokes. The greatest improvement in speed is usually made with successive, overlapping letter strokes, where the common sequences have full play. A widening gap, in contrast with such improvement, may leave the carriage throw or holding down the tabular key or capital shift slower in proportion. What if similarly irregular timing for the many common digraphs, the "number" sequences, and other symbol key strokes exists between you and other student typists? Nor do all these yet include differing times for the paper insertion or removal and the more special lever or key manipulations, which too frequently remain awkward, wasteful, and overslow until the expert state.

4. *Improved timing of all motion subcycles in proportion.* These surprising differences of timing and pace, unless carefully watched and brought along together, will not only persist but even increase, as between your digraph strokings and the capitalizing, the incessant thumbing of the space bar, the unavoidable carriage return with its usual delay in terms of key strokes, or the other varied manipulations. Yet each needs to be worked into the regular rhythm of your typing and the pace of each needs to be quickened in fairly equal proportions.

Use the carriage return as your illustration. The sharp beat at contact with the lever, the immediate relaxing and return of the hand, and the final answering click of the return contribute to your typing rhythm when made without hesitation. Listen to see how such sharp, rhythmic swings as your well-timed carriage throws enter into the rhythm of the line, the typings, and the returns, line by line. Is a contrary picture still typical of what happens in your typing? The long sweep of the hand against the carriage-return lever varied absurdly with Wells's [68] two operators. One typist took .87 second; the other, 1.28 seconds. The first placed his thumb against the hook and threw the carriage with a single extensor move of the arm; the second grasped with his fingers and gave a distinct twist to his slower return. These times were much slower when the new line was a paragraph. The indention was then located by a time-wasting space bar or backspacer! This carriage-return time rose to about 1.45 seconds. Even to use the marginal release just before the carriage return slowed the timing over one third (1.17 seconds). The marginal-release stroke itself absorbed from 1.0 to 2.5 seconds. This serious cutting down of the speed and rhythm is enough to condemn, except in emergency, the marginal release, the backspacer, and the strike over (even as *h* over *n*, *y* over *v*, *e* over *c*).

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[68] Wells, F. L., "On the Psychomotor Mechanisms of Typewriting," *American Journal of Psychology* (1916), Vol. XXVIII, pp. 47–70.

As you increase the relative speeds of all motions in continuing practice on straight copy, the complete operation of the typewriter sooner or later progresses as a balanced whole. Do you already find yourself thinking in terms of one whole typing cycle from paper insertion to paper removal — to yet another sheet inserted? All the numerous, irregular timings are to blend into sustained rhythm, so that your typing is steadily carried along with the least action.

5. *Flexible, individual paths of typing progress.* Any typewriting-class situation — same instruction, same exercises — is complicated. This fact is illustrated by Butsch[69] with two girls who were both quite expert at the end of their second year. Both made the *same* gain in speed of letter stroking (see Table XXX). What of the other timings? As registered on this apparatus, the first girl in one year improved by decreasing the time of her letter stroking from 40 to only 28, or 12 time units. During the same practice this really good student typist evidently neglected her capital-shift strokes, which actually became slower (91 to 97 time units). Even the improvements in the speed of her space-bar strokes (30 to 26) and in her carriage returns (254 to 202) failed to keep pace with the gain in her letter stroking.

The second girl not only bettered the time of her letter stroke from 42 to 30, or 12 time units, but also the time of her capital shift in the same proportion. This successful student typist cut down even further the times for her space-bar and carriage-return strokes.

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[69] *Op. cit.*

TABLE XXX

RATIOS OF SPACE-BAR, CAPITAL-SHIFT, AND CARRIAGE-RETURN STROKES TO LETTER STROKE AFTER A SECOND YEAR OF PRACTICE WITH TWO SUCCESSFUL STUDENTS
(From Butsch [70])

	Letter Stroke	Space Bar	Capital	Carriage Return
GIRL I				
First Year . . .	1.0	0.7	2.3	6.4
Second Year . . .	1.0	0.9	3.5	7.2
GIRL II				
First Year . . .	1.0	1.1	2.8	6.7
Second Year . . .	1.0	0.7	2.8	6.1

In other words, Butsch [71] suggests, apparently in learning to typewrite you *work out for yourself the relative speed* which you obtain in each of these motion subcycles, and this is not determined in very large measure by the instruction. Classmates under apparently identical conditions and the same teacher may be more unlike in their typing than a mixed group trained in various separate typewriting classes!

FLEXIBLE FAST PACES: YOUR OWN OPTIMAL RATE AS A BARRIER

You will find these faster flexible paces more difficult to win. In the course of your typewriting growth you have already resisted natural impulses to "go at your own rate." Even now you may be partial to a rate of typing that is felt as your own personal and best speed. Finding your own optimal rate of speed, in fact, has served as a valued, essential, personal discovery. An upsetting suggestion is now advanced by Griffith.[72] This optimal speed at which you seem to achieve your best results is often an artificial barrier against your further progress. This barrier may be less serious for you than for some other students. Even athletes appear to show tremendous differences that range from practically no sense of timing up to a pace clocked as closely as the ticking of an expensive watch. From studies of athletes who learned to trace out the circuitous path in a maze, Griffith concludes that chance habits of timing become set. This clinging to a set pace interferes with further advances. Your own preferred typing rate thus holds you clamped on what is often called a "plateau." This means that your typing outputs will not rise until you break with the old, personal rate and gain a new pace. Your continued progress to skilled operation is to this extent a problem of reaching a new optimal pace in your sequence stroking.

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[70] *Op. cit.*

[71] *Ibid.*

[72] Griffith, C. R., "Timing as a Phase of Skill," *Journal of Educational Psychology* (1932), Vol. XXIII, pp. 204–213.

UNDERLYING PERSONAL RHYTHMS IN TYPEWRITING

Does lack of rhythm peer out of any sheet typed on your machine? If so, you will want to hold everything for your drastic search to recover a rhythmic pace. Beneath these time rhythms are still deeper rhythms grounded in your bodily activity. If your stroking is reduced to simplest motor terms, recess periods being omitted and the movements being carried out with no relaxing into 200 and 300 repetitions, very striking waves appear in your speed curve. Your motor co-ordination rises and falls in several of these major waves, while minor rhythms give the wave a definite contour. Very striking differences appear in these wave outlines of different students. Such basic nervous and muscular rhythms exactly parallel, urges Wheeler,[73] changes in your attitude, your mood, your determination, and the ease of your control. Typing rhythms, basic but flexible, are dependent on physical, mental, and emotional adjustment and time.

INTERPRETATIVE SUMMARY

The study of correct motions is continued from the point of view of rhythm and timing. The essentials of typewriting are popularly summed up in rhythm. This is true even to the extent that ballistic stroking illustrates and defines rhythm. Its staccato blow produces the rhythmic beat. Once thrown, the starting muscles commence to relax. Opposing muscles then catch the finger and return it in an elastic rebound. The sharp tension of the throw, immediately followed by relaxing and retarding, invites rhythm. As long as the succession of sudden beats, relaxing, and retarding is sustained, rhythm is present.

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[73] Wheeler, R. H., "Basic Rhythms in Motor Learning," *Psychological Bulletin* (1928), Vol. XXV, pp. 159–160.

Naturally, the right of way in practice is assigned to ballistic stroking. The beginning typist practices correct stroking within a slow rhythmic pattern. Each fast, correct stroke is held in sequence to develop the overlapping between strokes, despite the slow pace. The slow pace permits definite delays for organizing the pattern of the motion to follow. In terms of student action, each initial delay is felt not as a pause, but as thinking of the next stroke while stroking the first. Automatic conditioning gradually shortens the interval between the stroking and its signals, so that the pace gradually quickens. A regular pace thus reinforces the conditioning signals for definite timing. Any interference from premature transcribing or similar prerequisites of more advanced levels is taboo. The stroking pace is increasingly moved forward at the *different rates* which are so simply regulated with machine dictation or with a mechanical type-pacer.

The simple rhythm of sustained ballistic stroking is complicated by added rhythms in music. The extremes of jazz or of classical music become admittedly serious interference. Nevertheless, musical tones appear to heighten the muscular action and suitable musical rhythms reinforce similar successions in the motions. Musical records, accordingly, are used with caution in simple musical forms for interesting but brief rhythm drills. Such brevity, in fact, applies to all rhythm drills. The discovery of a rhythmic pattern combined with relaxation is sought instead. Sustained rhythmic rates are made possible only by the practice of relaxation. The resulting smoothness recalls the musical term "legato." Conventional typewriting, by contrast, builds up tension in its students. The results of this inferior fluency deserve the borrowed term "plateau blues."

A release from class-group rhythms after 40 to 48 net words are attained assumes that the student is now ready to follow his own faster individual rhythms. Just how flexible these fast sequence rhythms must be is seldom realized until sequence times are measured. Some two-letter sequences, in fact, are two to three times faster than the slowest. Flexibility is protected by practice of varied copy, by slowing for awkward sequences with no sharp break in the pace, and by a "simplified" keyboard. The obvious possibilities for speed lie with the faster sequences stroked by fingers on opposite hands. Further irregularities appear in the time ratios between the stroking, spacing, shifting, and carriage returns. These respective ratios ordinarily may be 1 to 0.8 to 3 to 7. As the student works out for himself his relative timing for each, his paces for some operations in a typing cycle fail to improve in proportion. Gaps between the faster stroking speed and various manipulating may widen as the student follows his individual path of typing improvement. Against this advance to faster rhythmic paces, the optimal speed at which a student seems to achieve his best results often acts as an artificial barrier. Until the student breaks with the old, personal rate, his typing outputs cease to rise. Beneath these flexible rhythmic paces are still deeper rhythms grounded in physical activities that parallel changes in the student's typing attitude.

PART FOUR

WORKSHOP DISCOVERIES ABOUT DIFFICULT TYPING BEHAVIOR

CHAPTER XIII

TROUBLE SHOOTING FOR ERRORS

* * *

Reading Suggestions

To the Student Typist: First, catch the idea of using errors to improve your correct, fast motions, pages 342 to 345. The important section of this chapter tells how to count and study your errors, pages 378 to 389. There is also an important principle in drilling your errors, pages 361 to 368. Read at the same time Holsopple's interesting experiment, pages 364 and 365. Take the rest of the chapter for background. 1. Note why you need to look further than letter errors, pages 358 to 360. Skim rapidly the pages that follow on the efficiency of each letter stroke, to discover: (*a*) that some keys are used vastly more than others, pages 345 to 352 and 355; (*b*) that common digraphs hold down errors, pages 352 to 354, 356, and 377; (*c*) which digraphs are the most powerful, pages 354 to 356. 2. Read to assure yourself that most errors occur in common words, pages 368 to 372, and add four simple rules, page 372. 3. Make your view of errors definite by examining (*a*) coefficients of difficulty until you can use the list of typing demons, pages 373 to 376; (*b*) reading or "word" errors, to see these as a different kind of mistake, pages 390 to 392; and (*c*) the samples of errors that show each fraction of a second the typing is blocked by the interfering error, pages 392 to 394.

To the Psychology Student: The study of errors brings you at once into one of the livest and most valuable aspects of educational psychology today. In every academic subject you confront errors as signs of incomplete learning or thinking. Several pages repeat the mental hygiene approach, pages 342 to 345, and the scientific attitude, pages 345 to 389. If you enjoy simplified statistics, you will be interested in following the somewhat hidden influence of dominant digraphs, or language patterns, in the conditioning. The chapter launches into digraph errors, pages 352 to 360. Notice how the efficiency of each motion is first compared with its actual use or implied stimulation, pages 352 to 358. Notice how common digraphs upset the chances for errors, pages 352 to 354. The influence of common digraphs is then traced in frequent errors in motions of adjacent fingers, pages 354 to 360. These dominant patterns are listed, pages 365 to 368. Next notice the continued emphasis on learning patterns (Gestalt psychology), pages 363 to 365. At this point you will be interested in the Holsopple experiment with the Beta hypothesis, pages 364 to 366, and the brief review of conditioning that uses the serial pattern of common words and the spatial pattern of the keyboard as the illustration, pages 360, 361, 364, and 365. For a sample study of errors, in the psychology of school subjects, use discovery of the extent to which most errors occur in common words and the definite coefficients of difficulty that resulted, pages 368 to 376. Close your reading on errors with Wells's brief experiment: Notice the distinctions between the excessive action of any "beginner," human or animal, pages 389 and 390; the accidental reading errors that reflect a person's prior experience, pages 390 and 391; and errors in order or serial pattern, page 391. Study samples of the latter errors to bring out definite blocking by more common digraphs or other interference, pages 392 to 394. This prepares you to study fatigue.

To the Typing Instructor: Your reading of this chapter may well follow the outline for the student typists, except that you will want to fill in more detail. For example, you will want to add these points: analysis of keystroke efficiency in beginning typists, pages 369 to 373, and their excessive action, pages 389 and 390; outcomes that show why locating any common words in which errors persist is a needed first step, pages 378 to 382; overview of the whole discussion of word drills and their supplementary role, pages 394 to 398.

* * *

A POSITIVE ATTITUDE THAT ANTICIPATES ACCURACY

If you agree that an outstanding feature of your typing improvement is to be the discarding of wasteful motions, in what direction will your interests lie? Naturally, toward the kind of practice that prevents false and wasteful motions, errors, and fatigue. .You need feel no regrets over the passing of so many of your beginner's movements when the new and more efficient action suddenly emerges. At least you will feel no compunctions over the ruthless slaying of your false strokes. But an actual error is so disturbing that the spotlight of your thinking easily centers on it. By a perverse freak of human nature, so-called "accuracy" instructions in terms of avoiding errors often tend to produce them. A positive emphasis stressed by good mental hygiene would suggest that "speed and accuracy" rather than "avoidance of errors" be in the foreground of your typing attitude.

TROUBLE SHOOTING WHEN ERRORS PERSIST

It is only recently that typing students, already striving for "accuracy," have become really aware of errors. Hitherto many student typists have thought of "accuracy" as a heavy penalty for errors. It is still commonplace for the advanced student to keep his net scores rising while with him marches the same band of errors, neither more nor less. Butsch[1] has drawn one of the most carefully studied curves of an advanced learner's typewriting. In fifty days, or about seven weeks, this advanced student has increased his net scores from some 77 net words per minute to 86. At the start of these practice stretches he has been making 7 errors; at the close he has still been making from 7 to 9 errors. You will shortly be familiar, too, with the surprising discovery that superior advanced students have made relatively more errors on the most common English words than beginners. Isn't it a striking item that in the past specific errors have often been blindly overlooked as long as net scores were rising? Often neither instructors nor students have fully realized that the error curves were not improving.

1. *See errors as interesting symptoms.* If you already feel that an error in itself is a very serious matter, you are caught in a pitfall that awaits the perfectionist. Your interest is likewise killed when you are nagged over errors. To feel that only perfect student typing has a place in a typewriting class is hardly intelligent. So naïve and immature is a perfectionist's shunning of errors that the typing practice inevitably tumbles to an emotional level.

Why is perfect copy not essential at the start? Why is an error of slight importance in itself? Unless you also are a perfectionist, the answer must be obvious to you. The doctor describes it in a sarcastic phrase — he calls it *treating symptoms* instead of treating the underlying trouble. The symptoms of real trouble are slid over or even denied. Errors, however, remain as signs or symptoms or indicators that something behind the motion has missed. Errors are merely trouble indicators. Errors merely signalize underlying trouble in you, the machine, the copy, or other aspect of the typewriting situation. There is but one intelligent approach to errors. It lies in your asking, "Why have I made this particular mistake?" An error then becomes your cue to start thinking, *not retyping*. Problem shooting for errors should be the greatest indoor sport in typewriting classes. With the error as your cue, you will first look for your underlying difficulty. After finding the real trouble, you will plan to remove it. Then you will test your plan by trying it out. If your plan fails to work, what is your next step? Of course, a new plan. When your plan finally works, what has happened to the original error? It has been lost in the shuffle. It has disappeared. You have relaxed it away. After all, it was only the starting point on your path of problem solving.

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[1] Butsch, R. L. C., "An Experimental Study of Progress in Typewriting," Master's Thesis (University of Chicago, 1927).

2. *Avoid collecting isolated letter errors.* If you avoid being a perfectionist and view errors with interest rather than with abhorrence, what is a second pitfall? Really the second is a more definite variation of the first. It is the old fallacy that typing is at bottom a letter stroke. The copy reads *i* and you stroke *e;* the copy reads *s* and you stroke *a*. You keep a count: "I missed *e* 23 times, *s* 20 times, *t* 20 times, *d* 19 times, *a* 16 times, *o* 16 times, . . . *p* 4 times, *x* 3 times, *z* 2 times." Does this mean that your *e* stroke and *s* stroke need practice? Inspect these two strokes and probably you see at once that each is already a firm stroke!

That sequence study is not yet fully grasped is evident in the way the usual class error records still dillydally over artificial letter errors. Many typing students the country over still faithfully waste much time isolating and counting their letter errors. Perhaps your own error record sheet belongs in this very recent past wherein isolated letter errors have been considered a prime clue to the interference underneath. This is no reflection, however, on the pioneer diagnostic error charts by Lessenberry, Baker, or Blackstone. These charts have had their uses. At the very least in their employment a student is being reminded that errors are being made — perhaps as many today as weeks back. It is even likely that the repeated listing of persistent false strokes contributes to their disappearance.[2]

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[2] Nathanson, Y. S., "A 'Conceptual' Basis of Habit Modification," *Journal of Applied Psychology* (1929), Vol. XIII, pp. 469–485.

Listing your errors then becomes the first step in their disappearance. Lessenberry[3] has done as much or more than any expert in making you and other students aware of errors by a famous collection of 60,000 such letter errors. This well-known error count has more than justified itself by opening up, all over the country, the complicated problems behind errors. In accomplishing this pioneer first step against errors, Lessenberry has also realized that his total counts (5751 mistyped *e*'s, 4189 mistyped *s*'s, . . . down to 460 mistyped *z*'s) alone mean little or nothing. A distinction between isolated strokes and sequences is sensed when Lessenberry[4] hopes that typing students will show more "caution" in their control of sequence movements after studying his chart. The obvious confusion between vowels, for instance, may be a sign of mistaken syllables. Smith[5] is among the first to demonstrate that such letter-error counts are artificial and, except historically, of little value alone. You will sooner or later agree with his definite statement that knowing the number of times each individual letter is mistyped among 60,000 errors does not determine why it is mistyped. The intrusion of more frequent combinations and of difficult combinations cannot be definitely traced. Interference from unsuitable "speed" or "overstressed fluency" of the wrong kind cannot be definitely traced. Moreover, it will shortly be shown that the bulk of typing errors are sequence errors unrelated to isolated letter strokes. You will avoid this second pitfall, then, even as you avoided the first, by looking for the source of each error. In the light of its source any error becomes by itself a mere detail. Its significance lies in what it betrays.

RELATIVE KEY-STROKE EFFICIENCY

1. *Relative use of key strokes in typing copy.* If you are interested in digging into the facts behind typewriting errors, you will wish to include Hoke's pioneering studies. To discover how often each letter

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[3] Lessenberry, D. D., *Error Chart* (L. C. Smith and Corona Typewriters, Inc., Syracuse, New York).

[4] *Ibid.*

[5] Smith, H. H., "Problems in Diagnostic Testing and Remedial Teaching as Applied to Typewriting," *Second Yearbook* (Commercial Education Association of New York City and Vicinity, 1932), pp. 53–68.

is typed, Hoke[6] has counted the letters in a newspaper editorial, in business letters, in a chapter from Mark's *Gospel,* and in Ayres's "One Thousand Commonest Words."[7] In this treatment of the Ayres list, however, he has counted the number of times each letter was used by assuming that all the common words are equally used. A recount has convinced the authors that such letter counts must consider the varied frequencies with which the different, common words are used in ordinary running copy. In such a recount by Dvorak,[8] moreover, the amount of use of each letter is also scored on a basis that gives the usage of *e* a value of 1000. Notice in the final column of Table XXXI how this Dvorak revision changes considerably the relative weights assigned by Hoke to the different letters. This final column will go a long way in helping you realize what confronts you, for example, when you stroke *e* or *q*. Do you see that you must stroke *e* 1000 times to stroking *q* 3 times? In passing, you may observe also that all the 11 least-used letters taken together do not equal *e* in its actual use while typewriting.

2. *Estimated efficiency of letter key strokes.* Turning to actual errors, these studies next compare the extent with which you would use each key in order to estimate the efficiency of each letter stroke. The relative number of times *e* is mistyped, as compared with the number of times *e* is attempted, however imperfect the result, is considered 100%. For example, *h* on this basis appears more efficient, while *x* appears less efficient. Do you catch this striking comparison between key strokes from Table XXXII? The picture is hardly correct, however, unless the Dvorak counts alone are employed. Do you find these figures in the first column of Table XXXII? The smaller the percentage, naturally, the more effective the key stroke. For your convenience the key strokes are listed in the order of efficiency. Does it seem as though Table XXXII becomes a magnifying glass through which you look at errors? Thus, the *e* stroke has merely median, or ordinary, efficiency. But have you realized that

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[6] Hoke, R. E., *The Improvement of Speed and Accuracy in Typewriting* (Johns Hopkins Press, 1922).

[7] Ayres, L. P., *Measurement of Ability in Spelling* (Russell Sage Foundation, 1915), pp. 12–20.

[8] Dvorak, August, Unpublished Study, University of Washington, 1932.

TABLE XXXI

FREQUENCY OF USE OF LETTERS IN AYRES'S LIST OF "ONE THOUSAND COMMONEST WORDS"
(From Hoke [9] and Dvorak [10])

Letters	Unweighted for Frequency of Used Words				Weighted for Frequency of Used Words	
	Number of Times Used (Hoke)	Number of Times Used (Dvorak)	Frequency of Use Raised to Basis *E* — 1000 (Hoke)	Frequency of Use Raised to Basis *E* — 1000 (Dvorak)	Number of Times Actually Used (Dvorak)	Frequency of Actual Use on Basis *E* — 1000 (Dvorak)
E	734	733	1000	1000	43,051	1000
T	440	444	609	606	35,096	815
R	434	434	591	592	20,010	465
A	419	420	571	573	27,558	640
O	385	386	524	527	29,623	688
N	373	373	508	509	22,080	515
I	366	367	598	501	21,896	509
S	308	315	420	430	16,919	393
L	254	255	350	348	13,104	304
C	219	219	298	299	7,334	170
D	193	193	263	263	12,075	280
U	171	172	233	235	9,968	232
H	170	169	232	231	23,434	540
P	161	162	219	221	4,519	105
M	154	155	210	211	8,289	193
G	114	114	155	156	4,607	107
F	113	113	154	154	9,246	215
Y	107	108	146	147	9,040	210
B	97	97	132	132	5,408	126
W	90	91	123	124	9,479	220
V	60	60	82	82	3,441	80
K	36	36	49	49	2,440	57
J	14	14	19	19	437	10
X	13	13	18	18	420	10
Z	5	5	7	7	81	2
Q	3	3	4	4	116	3
Total	5433	5451			339,671	

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[9] *Op. cit.*

[10] *Op. cit.*

TABLE XXXII

RELATIVE EFFICIENCY OF KEY STROKES IN A COMPARISON BETWEEN ERRORS MADE BY SOME 100 TYPISTS IN ACTUAL TYPEWRITING AND FREQUENCY OF OCCURRENCE OF LETTERS IN ORDINARY COPY
(From Hoke,[11] corrected by Dvorak [12])

Letter	Indices of Efficiency (Per Cents)		Rank				Frequency	
			Efficiency		Letter Usage		Errors (Hoke)	Letters (Hoke)
	Dvorak-Hoke	Hoke	Dvorak-Hoke	Hoke	Dvorak-Hoke	Hoke		
W	38	63	1	4	13	18	84	132
H	41	55	2	2	5	9	223	402
O	67	82	3	8	3	4	462	561
P	69	46	4	1	20	17	73	158
N	72	79	5	6	6	7	372	469
I	74	78	6	5	7	6	378	484
B	77	60	7	3	18	16	97	160
T	78	92	8	10	2	2	636	685
A	93	87	9	9	4	3	596	684
R	94	104	10	14	8	8	440	423
U	96	100	11	12	12	13	224	223
F	97	204	12	20	14	19	209	102
E	100	100	13	12	1	1	1000	1000
S	100	81	13	7	9	5	395	486
L	111	97	15	11	10	10	339	349
Y	117	140	16	17	15	17	246	175
D	156	160	17	18	11	11	418	261
C	166	122	18	16	17	12	283	231
M	166	162	18	19	16	14	321	198
K	168	234	20	23	22	22	96	41
V	197	239	21	24	21	21	158	66
J	260	113	22	15	23	23	26	23
G	303	328	23	22	19	20	325	99
Z	1000	222	24	21	26	26	20	9
Q	1066	320	25	25	25	25	32	10
X	1400	700	26	26	23	24	20	26

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[11] *Op. cit.*

[12] *Op. cit.*

when you stroke *x* the chances of your making an error are 20 times greater than when you stroke *p*, or that when you stroke *q* the chances of your making an error are more than 25 times greater than when you stroke *w?* To realize such facts is, indeed, to mind your P's and Q's.

Recall the 60,000 typing letter errors on the "universal" keyboard collected by Lessenberry[13] in a still bolder drive against your false strokes. Furthermore, Smith[14] has compared these errors with the amount each letter is used,[15] in order to show its stroke efficiency. Unfortunately this comparison has also made use of the earlier letter counts. All estimates have therefore been refigured with the corrected Dvorak letter count. Remember that you are now looking at the key strokes in the light of 60,000 errors. If you will compare the more efficient key strokes with the less efficient strokes in Table XXXIII, you will be struck by certain disagreements. Or if you should figure, on a basis of 1.00, how closely the two ratings of Smith and Hoke agree, your result would be .72 only. Naturally the former is using an error count far superior in size. Do you notice that most of the efficiency is in the upper bank of keys where most of your typing is done on the old keyboard? What is your own experience with the more difficult key strokes? Do they seem to fall in the lower half of the list as revised by Dvorak? In the light of your own errors, which estimates seem more nearly correct?

3. *Relative improvement in beginners' key strokes.* With the beginning typists in the St. Louis schools the efficiency of the various key strokes is quite different[16] (see Table XXXIV). This St. Louis order seems based on the total letters in each test rather than on large letter counts used elsewhere. If you make a comparison, however, it is the home row that stands out with these young typists during the twelfth and sixteenth weeks' tests. Effective strokes to the upper bank of keys have not yet outdistanced those to the less-used home row (see Table XXXII). It is a striking fact that as yet their strokes to the inadequate home row on the old keyboard

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[13] *Op. cit.* [14] *Op. cit.* [15] Hoke, R. E., *op. cit.*

[16] Dake, L. G., "Are Some Typewriting Students Doomed to Failure?" *Journal of Business Education* (1929), Vol. II, pp. 13, 22–23.

TABLE XXXIII

RANK ORDER OF EFFICIENCY INDICES OF OCCURRENCE OF ERRORS RELATED TO OCCURRENCE OF LETTERS

(From Lessenberry,[17] Hoke,[18] Dake,[19] and from Dvorak-Ayres, Hoke, as estimated by Dvorak,[20] Smith,[21] Hoke)

Letter	Dvorak-Lessenberry	Smith-Lessenberry	Hoke	St. Louis Beginners
H	1	3	2	2
O	2	4	8	6
T	3	6	10	3
A	4	1	9	2
E	5	5	12	7
Y	6	8	17	5
N	7	9	6	13
L	8	7	11	4
W	9	17	4	9
P	10	2	1	14
I	11	11	5	15
R	12	12	14	17
U	13	14	12	18
S	14	10	7	8
M	15	15	19	20
F	16	20	20	11
C	17	13	16	10
D	18	18	18	16
B	19	16	3	21
G	20	19	22	11
V	21	21	24	19
K	22	23	23	22
X	23	22	26	
J	24	24	15	23
Q	25	25	25	
Z	26	26	21	

equal or exceed the key-stroke ratings drawn from all sorts of typists. Most of the other key strokes drop in efficiency for these beginners. On the upper bank, however, the *t* stroke, with its many dominant

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[17] *Op. cit.*

[18] *Op. cit.*

[19] Dake, *op. cit.*

[20] *Op. cit.*

[21] *Op. cit.*

TABLE XXXIV

INDICES OF OCCURRENCE OF ERRORS RELATED TO OCCURRENCE OF LETTERS AMONG 659 AND 570 FIRST-YEAR TYPING STUDENTS IN THE ST. LOUIS SCHOOLS, 1929
(From Dake[22])

Rank	Letter	Twelfth Week	Sixteenth Week	Difference
1	H	.34	.43	– .09
2	A	.52	.80	– .28
3	T	.54	.81	– .27
4	L	.66	.75	– .09
5	Y	.82	.70	.12
6	O	.79	.78	.01
7	E	.79	.85	– .06
8	S	.90	.80	.10
9	W	.74	1.11	– .37
10	C	.88	1.00	– .12
11	F	1.11	.96	.15
12	G	1.01	1.06	– .05
13	N	1.39	.93	.46
14	P		1.21	
15	I	1.37	1.15	.22
16	D	1.62	1.22	.40
17	R	1.27	1.87	– .60
18	U	1.00	2.26	– 1.26
19	V	1.71	2.19	– .48
20	M	2.49	1.63	.86
21	B	2.85	1.71	1.14
22	K	3.61	1.93	1.68
23	J	5.22		

combinations, has been quickly won. The common *y* stroke has shown unusual improvement during the interim practice. On the lower bank, the fairly successful *c* stroke and *v* stroke are slowly dropping in rank as other strokes rise relatively. A quite remarkable play has occurred around the *n* stroke. Obviously an awkward reach for the beginner, *n* is featured in many dominant digraphs, or two-letter combinations. Though below par in the opening test, during the four weeks of interim practice it has been forging ahead more than any other key stroke. Over the four weeks in general, speed appears to have doubled, while the error rate has remained constant. Illustrating diagnostic use of such tests, incidentally, a St. Louis girl constantly wrote *a* for *s* and *u* for *v*. She seemed a total typing failure until a brief observation of this error difficulty showed the left-hand third finger bent backward. The finger had been broken and improperly set and was not being used. The girl's failure to use it was gradually corrected by special practice.[23]

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[22] *Op. cit.*

DOMINANT DIGRAPH EFFECTS

1. *Errors in frequent digraphs favored by chance.* Along with an early count of letters and actual errors, Hoke[24] has also taken another forward step. He has counted the two-letter sequences of 647 errors. It is obvious that if you seldom type a certain letter, its chances for errors are few; whereas if you type a letter frequently, its chances for errors are many. His facts show, of course, that the most-used letters do leave these great piles of errors in their wake. By counting two-letter combinations, known as digraphs, further light is cast on just the spots where your errors will most likely be heaped. If you seldom use a certain letter, only a few strokes and fewer errors can possibly follow it. If you type another letter often, more strokes and errors will follow it. You will have many more chances to make errors both *on* and immediately *after* the most-used letters. What letters did these 647 errors follow? After most common letters like *e* and *a*, there are 81 errors apiece; after a letter of only middling usage like *m*, 30 errors; after least-used letters like *z*, 5 errors; and after infrequently used letters like *j*, *q*, *x*, no errors.

2. *Chances of error upset by common digraphs.* You appreciate that Hoke took this forward step a decade ago at a time when the letter stroke rather than the sequence of at least two successive strokes was still considered the unit in typewriting. The fact that typewriting succeeds because the succession of overlapping strokes is faster than any stroke made separately had not yet been clearly

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[23] Dake, *op. cit.*

[24] *Op. cit.*

understood. Hoke was therefore unable to carry forward his own suggestive step toward digraphs. Accordingly he missed the connection between accuracy and the combination of letters with which any one letter may happen to be written.

The chances, as you have seen, favor more errors following the more-used letters. Yet what happens when you think about *most common sequences* instead of common letters? A quite startling fact emerges. The most common digraphs seem to hold down the errors until the relation between errors and frequency of use is no longer close, but merely slight. Expressed on a basis of 1.00, the figure sinks to .24, which is slight. You will see this clearly if you inspect in Table XXXV thirty most common two-letter sequences alongside the errors as listed. These top seven sequences occur for you and

TABLE XXXV

OCCURRENCE OF ERRORS RELATED TO OCCURRENCE OF TWO-LETTER SEQUENCES IN DATA
(From Hoke[25])

Digraphs	Frequency	Errors	Digraphs	Frequency	Errors
th	50	4	nt	24	4
er	40	16	ea	22	3
on	39	8	ti	22	0
an	38	8	to	22	4
re	36	12	it	20	8
he	33	5	st	20	8
in	31	2	io	18	0
ed	30	12	le	18	14
nd	30	4	is	17	4
ha	26	10	ou	17	6
at	25	9	ar	16	10
en	25	0	as	16	12
es	25	10	de	16	0
of	25	2	rt	16	0
or	25	10	ve	16	5

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[25] *Ibid.*

other typists more than twice as frequently — 2.34 times as often as do the last seven sequences. Yet these first sequences show only 1.49 times as many errors. You will notice the surprisingly few errors for such very highly used sequences as *th* and *in* and *en*. No, the picture is not as simple as it seemed to be in the Johns Hopkins laboratory ten years ago. Somehow and from somewhere there is very serious interference with your typewriting adjustment. In your own typing such interference may pile up errors for which you are not to blame.

3. *Superficial interference from finger overloads.* Impressed with the piling of errors on the most-used letter strokes, Hoke[26] has guessed that interference arose from overloading of certain fingers. He has been able to show, if you except the gaps in his counting method, that your left little finger must make nearly 3 strokes to 1 stroke by your right little finger. Therefore Hoke[27] would change your present typewriter keyboard until these loads balance. He has shown that your left second finger must make more than 2 strokes to only 1 stroke by your right second finger. Therefore he would change your keyboard until these loads balance. But typewriting is not a sum of the tappings by each finger, whether more or less. Sensational as is the picture of overloaded fingers, presented elsewhere in detail, Hoke's guess concerning hidden interference is incomplete. In the light of your own thinking about typewriting, what is your guess?

Are you ready for a final overview of these heavy letter-error counts before turning to the more practical approach of thinking about an error in its actual word and line setting?

4. *Effect of dominant digraphs on adjacent errors.* Adjacent errors, where the key stroke is falsely directed to an adjacent key, amount to 60% of the 60,000 errors in the Lessenberry collection. Yet there is little difference, except in awkwardness of reach, between errors with neighboring and more distant keys. The stroke itself is effective. Only the direction to a key is at fault. See what happens when you compare the number of times a letter actually is stroked with its number of adjacent errors. The relative per cent of adja-

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[26] *Op. cit.*

[27] *Ibid.*

cent errors for the amounts each key stroke is used appears in Table XXXVI. A smaller index than 100 shows greater efficiency; a larger index, increasing errors.

TABLE XXXVI

RATIOS OF FREQUENCY OF LETTER STROKES TO FREQUENCY OF ADJACENT LETTER-STROKE ERRORS EXPRESSED IN PER CENT, "UNIVERSAL" KEYBOARD
(Data from Lessenberry,[28] Dvorak,[29] and Ayres [30])

Finger	Left-hand Fingers					Right-hand Fingers				
	No. 4	No. 3	No. 2	No. 1		No. 1		No. 2	No. 3	No. 4
Letter Strokes	q *	w 192	e 100	*r 208*	t 108	y 147	u 188	i 142	o 100	p 120
	a 84	s 231	d 291	*f 271*	*g 477*	h 82	*j* *	k 540	l 143	
	z *	x *	c 250	*v 641*	*b 400*	n 164	*m 245*			

Outstanding, first, in this picture of the common keyboard is the poor record of the lower row of keys, except for the *n* stroke. Incidentally, the seldom-used key strokes (*x* and *z*, as well as *q* and *j*) reach astonishing inefficiency ratios well above 1000.

A second outstanding fact is the poor record of the first or index fingers revealed as a pattern of inefficiency (in Table XXXVI). Why? These letter-stroke errors reflect the letter combinations of which they are a part. The first-finger patterns are dominated by the terrific frequencies of *an, at, en, ha, he, in, it, nd, on, te, to, th, yo.* As the letters *t*, *h*, and *n* belong to dominant conditioned patterns, most of the stimulation from use of the first finger of either hand lies in these patterns. By contrast, the weaker letter patterns of the first fingers are in a sad state. Their conditioning signals are too slight for this competition. The entire picture reflects incidentally the overloading of these first fingers and primarily how the less dominant patterns suffer.

The entire keyboard picture further reflects overpressure on the left hand from beneath which only *a* strokes and *e* strokes and *t* strokes are elevated by definite dominant patterns. This follows from the intense stimulation in typing high-frequency digraphs of *an, ar, as,*

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[28] *Op. cit.*

[29] *Op. cit.*

[30] *Op. cit.*

at, *ea*, *ha;* *ed* and *de*, *en*, *er* and *re*, *es* and *se*, *et* and *te*, *he*, *le*, *ve;* also, *th*, *ti* and *it*, *to* and *ot*, *st*. So dominant are the conditioned *e* digraphs that the *r* digraphs, with one half the intensity of the former's stimulation, suffer despite the high frequency of *er* and *re*.

5. *Omission of dominant digraphs from the home row.* Your possible tendency to stroke a home key instead of making the correct finger movement to the key above or below is also emphasized by Lessenberry.[31] The striking feature of errors in the home row of the common keyboard is the obvious fact that these center in the supposedly stronger fingers. Glance at Table XXXVI to find these excess errors for first and second fingers on the home row. Only the dominant conditioned digraph patterns which hold *h* seem to rise superior to this class of errors. Such sequences, not isolated letter strokes, are the essential units in typewriting. The "universal" keyboard centers so few of these dominant combinations in its home row that this unfortunate omission is actually conducive to error.

6. *Summary of adjacent false stroking.* When you compare relative skills in avoiding all errors, the picture is largely unchanged. The four important letter strokes that show fewer adjacent errors offset this improvement at once by confusion between left-hand and right-hand stroking, between *a* and *e*, *i* and *u*. However, the letter strokes *y* and *n* notably lose in relative skill when only adjacent errors are considered. Are these not keys which you would expect to suffer from misdirected adjacent stroking?

7. *Effect of common left-hand digraphs on errors in opposite hands.* Another type of error reveals how the present keyboard is unbalanced in the play of your left hand against your right hand. Note that *e*, *d*, and *f* dominate the opposed letter of the right hand, owing to the greater intensity of the patterns to which they belong. These errors were:

i for *e*, 907 errors	*k* for *d*, 287 errors	*j* for *f*, 140 errors
e for *i*, 1019 errors	*d* for *k*, 484 errors	*f* for *j*, 176 errors

The moment these errors are related to the actual use of the key strokes, this left-hand dominance on the old keyboard is clear:

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[31] *Op. cit.*

i for *e*, 100 errors	*k* for *d*, 113 errors	*j* for *f*, 71 errors
e for *i*, 220 errors	*d* for *k*, 935 errors	*f* for *j*, 1940 errors

Lessenberry,[32] in his study of 60,000 errors, also calls attention to the general confusion in the use of vowels in sequences:

e was struck	for *i*	1019 times	*i* was struck	for *o*	915 times
	for *a*	494 times		for *e*	907 times
	for *o*	174 times		for *u*	560 times
	for *u*	85 times		for *a*	159 times
o was struck	for *i*	1290 times	*a* was struck	for *e*	560 times
	for *a*	210 times		for *i*	148 times
	for *u*	154 times		for *o*	126 times
	for *e*	134 times		for *u*	46 times
u was struck	for *i*	519 times	*u* was struck	for *e*	64 times
	for *o*	123 times		for *a*	33 times

8. *Keyboard interference from awkward digraph reaches and hurdles.* Frequently intruding in this parade of isolated-letter errors, do you catch the underlying interference of an awkward keyboard? Underneath the poor record of key strokes to the lower row, for instance, do you see reaches from lower to upper banks of keys more like hurdles over an obstructing home row? Gilbert[33] pointedly deplores the overproportion of these leaps between top and bottom keys and ridicules calling the obstructing home row "guide keys." The mere fact that the high-frequency digraphs *ce* and *ec* or *ed* and *de* must be stroked throughout by the same finger suffices to show that the *d*-stroke and *c*-stroke locations, for example, are serious stumbling blocks to your future fast writing. In fact, *de* has been mentioned as among the slowest of sequence times. When you note, likewise, the unavoidable delay of the first finger as it jumps from *f* to *t* or *r*, should you expect even the high-frequency trigraphs *oft* and *for* to lift the *f* stroke out of its excess of errors? However, such keyboard interference has already been summarized.[34] About all you can do is to struggle as best you can against interference for which you are in no sense to blame.

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[32] *Ibid.*
[33] Gilbert, W. A., *The Orthographic Keyboard* (Shaw and Borden, 1930), p. 63.
[34] See pp. 205–239.

9. *Summary of interference with digraphs due to keyboard locations, awkward reaches, weaker finger and hand overloads.* There is a current impression[35] that the relative skills of these various letter strokes show no relation with location on the "universal" keyboard, with reaches, with weak fingers, or with strength of hands. If you should use a balanced keyboard, this impression would be more nearly correct.

Similar *locations* are, first, cleverly compared. Thus, the location of a skillful key stroke on the right hand may parallel the similar location of an unskillful key stroke on the left. For example, the location of fairly skillful *p* stroke parallels the similar location of unskillful *q* stroke. It is true that these locations are similarly placed, but their relations to the total keyboard are very different. A key location has no importance until arranged with other locations so as to force common digraphs into reaches that are efficient (or awkward) in varying degrees. Thus, the *p* location can absorb the activity of an underloaded finger. The *q* location is on a key often having more mechanical resistance, in the territory of finger stroking dominated by the *a* sequences. Far more important is the fact that the *p* stroke combines in fairly strong digraphs, such as *pa, pe, pl, pr, op*, so that its digraph intensity is 20 times as great as is the case with the weak *q* stroke. This masking of the indirect influence of location is also illustrated in the massing of errors on the central home row (*dfgjk*).

As to *reaches*, unskillful key strokes in the home row are compared with skillful strokes that require reaching to other banks. Even in the home row, for example, unskillful *j* is contrasted with the side reach to skillful *h*. These are apt illustrations in an admirable study of errors. Nevertheless, the retarding influence of reaches is already demonstrated by other obviously awkward reaches and hurdles elsewhere on the keyboard. In the case of the *j* stroke, it is thus natural to assume that the ease of a stroke directly upon a guide key is offset, in fact blanketed, by a more powerful influence. This influence appears in the contrast between the terrific intensity of the *h* sequences and the abnormally weak digraph usage of such a stroke as *j*.

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[35] Smith, H. H., *op. cit.*

As to *weaker fingers*, fairly skillful stroking by the weaker fourth is contrasted with certain unskillful stroking by the stronger first finger. Here, too, the advantage of a stronger, less-fatigued finger may be hidden under a deeper influence. For example, take the superiority of the *p* stroke to the *j* stroke. The weaker right fourth finger, stroking *p*, is underloaded. This weaker finger has virtually nothing else to do but loaf along (if the shift-key strokes are canceled out of the picture). The stronger first finger, stroking *j*, is overloaded. More important, however, is the fact that the digraph intensity of the *p* stroke is 16 times as great as is the case with the less skillful *j* stroke. Turning to the left hand, the dominant *a* digraphs may be expected to shift any weakness of the left fingers elsewhere in the form of errors. This appears in the inaccuracy of *q*, *w*, *z*, *x* with the more easily fatigued little and ring fingers on the left hand.

As to *strength of hands* and the advantage to the usually stronger right hand, left-hand letter strokes in the upper 50% of skill, as determined by relative frequency of errors, are compared with right-hand letter strokes. In such a comparison, however, four left-hand letter strokes have no counterparts for the right-hand strokes. These are *a*, *z*, *x*, *c*. Of these, using the Dvorak recount of letters,[36] only the *a* stroke seems effective. When the remaining eleven left-hand strokes are compared with the eleven right-hand strokes, the inferiority of the overloaded left hand is evident: only four left-hand strokes remain comparable to eight skillful right-hand strokes. In other words, there are seven less-skillful left-hand strokes to three less-skillful right-hand strokes, as determined above.

In short, all these several factors, which a direct impression[37] might seem to dismiss, are indirectly present. These are keyboard locations, inviting hurdles and awkward reaches; readily fatigued, outer fingers upon the left hand; and a fairly general overwhelming load on this hand. The entire picture is vastly complicated both by the greatly varied intensities of the more common digraphs and the unrelated "universal" keyboard arrangement.

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[36] See Table XXXVI, p. 355.

[37] Smith, H. H., *op. cit.*

The fact, however, is clear-cut when errors are counted from typescripts written with a "simplified" keyboard.[38] The excesses of errors due to keyboard locations which force needless hurdles and awkward reaches disappear. The errors then occur quite as chance would distribute the slips in technique from among many differing typists. In effect, the efficiency of each key stroke follows rather closely the usage of its letter in common words.

LINE SETTING OF ERRORS

1. *Mistyping as sequence errors.* An advance is now made toward solid ground. Smith[39] tells you that frequent sequences are as important as frequent single letters. A sequence is a definite pattern of successive overlapping strokes. The pattern is always the real unit of which you should be aware in effective typewriting. You realize by now that the curious behavior of a beginner is not typewriting. As this novice advances, he will actually feel the dropping away of digraph letters and the emergence of words as wholes. Indeed, he will feel the letters disappear very early with the shorter, more familiar words. In your own experience you have felt time and again at your brightest moment this vanishing of letters into certain word patterns. The rise of these compact patterns is characteristic throughout virtually all typewriting improvement. To think in terms of letter strokes is to block error elimination. The longer you are practiced in tapping isolated letters, the more difficult does successful typewriting become. Very likely you are already convinced that key strokes have little, if any, significance in useful series.

2. *Smith's formula for attacking typing errors.* For your guidance and for clarifying what is meant by your attack on errors in their line settings, the following altogether admirable conclusion is advanced:

> Improvement will be most effective when the error is practiced in the original situation — in the sentence or line. If the error

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[38] See Davis, D. W., "An Evaluation of the Simplified Keyboard," *Journal of Business Education*, May, June, September, and October, 1935.

[39] Smith, H. H., *op. cit.*

cannot be conquered in that setting, attack the phrase. If necessary, then attack the word. It is only sometimes that a word must be broken up into its fingering combinations and even then such combinations may be quite different from their correct syllabication. Only in extreme cases will single movements have to be practiced, and these will usually be more or less complex movements, such as shifting and returning the carriage.[40]

Few, if any, experts have decried with such concise adequacy the current fallacy of isolated letter stroking and isolated letter errors. Successful typewriting is ordered, serial action in which isolated letter strokes exist only by artificial dissection which does violence to their actual fusion.

3. *Corrective drills for sequence errors.* Test your grasp of this basic fact by reading the series of remedial drills listed below which have been suggested by Baker.[41] Then check your list of answers to the two questions:

Assignment one: Point out each Baker drill which violates the formula that skill improvement practice will be most effective when the difficulty is practiced in the original setting or line; only if necessary, in the phrase; only if necessary, in the word; seldom, but only if necessary, in the fingering combinations. How many drills did you catch?

Assignment two: Point out each Baker drill which violates the similar proposal that sequences should be learned as they will be used. Are these two guide lines identical?

Baker Remedial Drills[42]

1. *Faulty Shifting*
   - *a.* Write 2 lines of the word in which the error occurred.
   - *b.* If in the left hand, write 2 lines of *zaq*.
     If in the right hand, write 2 lines of / ¢½.
2. *Faulty Line Spacing*
   Write one column (29 lines), double-spaced, of the first word of the line irregularly spaced.

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[40] Smith, H. H., *op. cit.*

[41] Baker, H. G., "Diagnostic Studies in Typewriting," *The Balance Sheet* (1929), Vol. X, pp. 233–234.

[42] *Ibid.*

3. *Short Page*
   Write 4 *full-page* columns of four different words.
4. *Short Line*
   Write line 4 times, getting at least 61 strokes to the line.
5. *Words Omitted*
   Write 2 full lines of word omitted *together* with preceding word.
6. *Words Misspelled*
   - A. Left-hand Errors
     - *a.* Finger No. 1
       - *aa.* Write 2 lines of word misspelled.
       - *ab.* Write 2 lines of *bgt5*.
       - *ac.* Write 2 lines of *vfr4*.
     - *b.* Finger No. 2
       - *ba.* Write 2 lines of word misspelled.
       - *bb.* Write 2 lines of *cde3*.
       - *bc.* Write 2 lines of *3edc*.
     - *c.* Finger No. 3
       - *ca.* Write 2 lines of word misspelled.
       - *cb.* Write 2 lines of *xsw2*.
       - *cc.* Write 2 lines of *2wsx*.
     - *d.* Finger No. 4
       - *da.* Write 2 lines of word misspelled.
       - *db.* Write 2 lines of *azaq*.
       - *dc.* Write 2 lines of *aqaz*.
   - B. Right-hand Errors
     - *a.* Finger No. 1
       - *aa.* Write 2 lines of word misspelled.
       - *ab.* Write 2 lines of *nhy6*.
       - *ac.* Write 2 lines of *mju7*.
     - *b.* Finger No. 2
       - *ba.* Write 2 lines of word misspelled.
       - *bb.* Write 2 lines of *,ki8*.
       - *bc.* Write 2 lines of *8ik,*.
     - *c.* Finger No. 3
       - *ca.* Write 2 lines of word misspelled.
       - *cb.* Write 2 lines of *.lo9*.
       - *cc.* Write 2 lines of *9ol.*.
     - *d.* Finger No. 4
       - *da.* Write 2 lines of word misspelled.
       - *db.* Write 2 lines of */;po*.
       - *dc.* Write 2 lines of *Op;/*.

7. *Transposition of Words*
   Write 2 lines of last word before transposition *together* with word that should follow.
8. *Faulty Paragraphing*
   Rewrite entire paragraph.
9. *Faulty Punctuation*
   Write 2 lines of punctuation mark together with *preceding* word.
10. *Faulty Spacing*
   Write 2 full lines of words between which faulty spacing occurred.
11. *Words Wrongly Divided*
   Write 2 full-page columns of these words, writing exactly as each should have been written in the test.
12. *Piling Letters*
   Write 4 lines of word in which letters piled.
13. *X-ing*
   Rewrite entire test.
14. *Rewritten Matter*
   Write 2 lines of last word *before* rewritten matter *together* with words rewritten.
15. *Cut Characters*
   Write 2 full lines of each word in which characters are cut.
16. *Irregular Margin*
   Write 2 full-page columns of each word out of margin.
17. *Words Inserted*
   Write 2 lines of words before and after insertion.
18. *Any Other Errors*
   Each student shall decide for himself what the drill shall be.

Another suggestion is that you make corrective drills for every error in a test before you take part in the next tests.[43] Are you perhaps ready to suggest other corrective word and sentence drills which you would prefer to make for your repeated errors? Have you already collected words and phrases that carry your errors, and have you built them into practice sentences?

Whenever it comes to individual drills, particularly after the first preliminary tryouts of an unfamiliar keyboard are past, question any urge to break your practice into piecemeal details. You may not yet realize the value of learning by complete patterns.

[43] Baker, H. G., *ibid.*

Piecemeal drill of a single word, for instance, should happen only in full view of the risk in wasted effort that may follow. In short, the piecemeal drill, to be tolerated, must justify a reason for its existence. Several of these definite aims behind such word drills are suggested:

(*a*) During the earliest practice to find the keyboard reaches of the various digraphs, the simplest sort of copy helps avoid confusion. If undue hesitation confuses the typing of simple sentences, words are tried alone. The slower the student, the more it seems necessary to break complete sequences into parts.

(*b*) During the early practice to master keyboard locations, the ring fingers and the little fingers tire easily. Freedom and resistance against fatigue are brought to these fingers by drilling upon carefully chosen words. These words may or may not be in simple sentences. Surely you have already noticed that these early sentences cleverly repeat common digraphs, such as a series of *a* digraphs or *s* digraphs.

(*c*) Not infrequently you complete your attack on a difficult word by first thinking of the entire motion pattern (including the space-bar stroke), typing quickly, then relaxing in a pause. This is problem solving applied to a word drill.[44] You practice what Smith would call "flash execution" for common words. Shortly, useful line drills, cautiously chosen to increase the firmness of your stroking common words, will again be brought to your attention.[45]

(*d*) Mention has already been made concerning the place of piecemeal finger drills and gymnastics in "warming-up" exercises, chiefly for the weaker, less skillful, and more easily tired ring fingers and little fingers.

Learning by wholes is modified in these ways in order to attack special difficulties in technique or copy. In the same manner, you recall that you break a typing motion into steps, or parts, in order to rebuild it, by planning, into a smoother, faster whole motion. In the practice of a new musical selection, by way of analogy, the music is first played in its entirety. You then go back to any more difficult measures that have been inadequately rendered, attacking each separately until these measures in turn are freely played as part of the whole selection. This intelligent attack on difficulties has no reference to any deliberate singling out of some isolated word for individual drill, repeated over several lines merely because you have mistyped its sequence. If you expect to reach accuracy by the monotony of endless recopying, you should experiment by watching other student typists make faster improvement without it. Drilling a given word with the machine making the same humdrum beat, line by line, is the height of monotony. It will sing you to sleep.

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[44] See the emphasis upon such drills in SoRelle, R. P. and Smith, H. H., *Gregg Typing Techniques and Projects* (Gregg Publishing Company, 1931), p. 8.

[45] See pp. 372–376.

As a matter of fact, however, you can with fair safety utilize these old-fashioned, continuous word drills to discard errors by their monotonous repetition. The only proviso is that you must drill this word not as it should be, but exactly as you have misspelled it in your repeated error. Holsopple and Vanouse[46] supply a clear-cut demonstration. Typing errors have been collected from 40 students just beginning to transcribe their shorthand notes. Each word that the typist could spell orally has been considered a constant automatic typing error if misspelled four times with the typewriter. Eleven typists have then practiced these word errors of theirs. One half these words have been drilled as correctly spelled. One half the words, however, have been drilled as actually misspelled on the typewriter. Each word drill has run for eight solid lines! Each typing drill has then been checked by a dictation using the same words. Which errors have been eliminated? You know the answer if you understand how conditioning automatically works. No errors have appeared in the words drilled as misspelled. Thirty errors have appeared in the words drilled as correctly spelled. One student typist, for instance, has misspelled *occassioned* four times after drilling it correctly. After drilling this misspelling, this error has disappeared. In short, its monotonous repetition as misspelled without reinforcement has disrupted the error.

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[46] Holsopple, J. S. and Vanouse, I., "A Note on the Beta Hypothesis of Learning," *School and Society* (1929), Vol. XXIX, pp. 15–16.

An interesting mixture of the old and more especially of the new in typing drills appears in the White[47] "accuracy drills." Here are a few of the vanishing nonsense combinations, and here are the earlier isolated word drills. Notice that the former are few and that the isolated words are repeated at the most only three times in succession. Right alongside observe the systematic and admirable straight-copy drills. It would be significant to compare a group typing all three of the White drills with another group typing only the last.

These drills are an admirable sample because they are built upon the study of 20,623 actual typing errors on the "universal" keyboard, as follows:[48]

Substituted strokes (40%)	Double strokes (2%)
Omitted strokes (20%)	Capitalizations (2%)
Spacing (15%)	Syllable divisions (1%)
Transposed strokes (15%)	Repeating words (1%)
Inserted strokes (3%)	Omitting words (1%)

The actual words in which these errors occur are retained and used in the drills. To say that *n* is transposed for *a* on the old keyboard 76 times means little. To know that *n* is stroked for *a* several times in such sequences as *chance*, *change*, *exchange*, *perchance*, is a definite help for overcoming that error.

Such errors, in fact, are expected so long as stroking of the *word* is not yet compact. They represent excessive or irregular delays between strokes needed for this word. During such delay the stroking more likely follows an easier digraph reach, such as inward to a stronger finger rather than outward to a lesser finger. Or faulty ordering is more likely to follow as a reading error. Its chances, for example, may increase from left to right through the word. Or there may enter, as a further instance, an accidental anticipation of a more distinctive letter (such as *d* in *disadvantage*). In fact, a great variety of conditioning signals that have not yet disappeared from the word may then bring premature anticipations of strokes.

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[47] *Typing for Accuracy* by W. T. White. Reproduced by permission of, and special arrangements with, the publishers, The H. M. Rowe Company, Baltimore and Chicago. Pp. 33, 41, 114, 122–128.

[48] *Ibid.*

Often the influence of more familiar digraphs or of longer, familiar letter combinations is easily traced.

In lively, interesting practice, however, the motions needed for the word will approach more and more closely their proper signals. The errors are literally squeezed out by your typing at regular rates. Delays between needed strokes, in correct order, then become not only regular but more and more slight. As these delays grow slight, the strokes come closer and closer together. Soon the word is typed as virtually one movement — correct because compact. Keep in mind Lepley's[49] principle that the stability of each word typed *varies inversely with the length of delays between strokes.* Short, lively, widely separated drills on the word in its sentences should reinforce its correct *order* and thus hasten the error into discard. If you do continue to meet the same error, this shows that for you the incorrect *order* has already become automatic. You might postpone further drill, perhaps until practice of similar, common words weakens the intruding stroke. It is also possible that in sentences which you drill the signals for surrounding words intrude before you can correctly type your word.[50] Accordingly, you attack the word alone, as already advised, then later work it back into sentences. Or by short, concentrated word drill in lines that mingle this word with similar common words, you may bring the desired firmness to your stroking.

On the other hand, if you should take this and other "false" strokes, isolate them from common words and drill them, what would happen? You would neglect the wide or irregular delays in the original words and lines. You would not work the words back into meaningful sentences. You would fail to develop any compact overlapping in these words. Whenever you later attempt common words in sentences, your chief result will then be continual, irregular interference. In any event, these straight-copy "accuracy drills" by White[51] and Reigner serve as a systematic, useful model for devising your own straight-copy and related drills directly on your own word errors.

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[49] Lepley, W. M., "A Theory of Serial Learning and Forgetting Based upon Conditioned Reflex Principles," *Psychological Review* (1932), Vol. XXXIX, pp. 279–288.

[50] Compare Smith, S. and Powers, F. F., "The Relative Value of Vocabulary and Sentence Practice for Language Learning," *Journal of Social Psychology* (1930), Vol. I, pp. 451–461.

[51] *Op. cit.*

Remember that it is the stimulation which counts, not the repetition, and that stimulation comes mostly from yourself and your own typing tensions. Remember that a drill may either attach or detach a motion, whether false or correct. As long as you correctly practice sequences in their natural settings, automatic conditioning gradually eliminates the action not needed. The extinction of your errors is more or less automatic [52] because what goes on is elimination of action. This brings you finally not only speed,[53] but also a "steady state" in all typing situations.

BULK OF ERRORS FROM MOST-COMMON WORDS

1. *Sequence errors by superior second-year typists.* Sequence study as a "guide line" for the insight into your typing errors is elevated to its rightful prominence in word studies by the authors.[54–55] After you discover how the cream of *second-year* high-school typists in the State of Washington have suffered over the 50 simplest everyday words in English, you will cease to think of most errors apart from word sequences. You will be converted to the necessity of knowing in what words or what types of patterns your errors are most frequent.

Competing for honors in the 1927 state contest, these 84 superior young contestants have typed for fifteen minutes and have averaged a little over 25 errors per student for the usual penalty of 1275 strokes. This is a loss of 17 words per minute.

Every error on a more common word has been noted until the accumulating, falsely directed strokes actually have amounted to 1018 errors. Virtually 1000 errors within fifteen minutes on the 1000 most common words in English! No sequence has been counted unless it belongs in the Ayres list of the 1000 most-used English words. On the whole, we are a people of few words. Yet the few words we commonly use seemed to hold considerable difficulty for these advanced students in typewriting. Perhaps you wonder where or how 1000 errors could have intruded upon the 1000 most frequent English words. Do you find it astonishing or perhaps absurd that 453 errors have been on the simplest, shortest 50 words known, little words like *the?* More than one half these 1000 typing errors (56%) have been made in the first 100 words of the Ayres list. All these words except seven — *very, about, other, letter, truly, after, over* — are the simplest monosyllables in the English language. Most of these words are spelled with a high degree of correctness by pupils in the primary grades.

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[52] Humphrey, G., "Learning and the Living System," *Psychological Review* (1930), Vol. XXXVII, pp. 497–510.

[53] Debra, F., "The Elimination of Unnecessary Movements in Typing," *American Shorthand Teacher* (1930), Vol. X, pp. 307–309.

[54] Ford, G. C., "A Study of Typewriting Errors (Common Word Errors in Typewriting)," Master's Thesis (University of Washington, 1928).

[55] Dvorak, A. and Ford, G. C., "Typewriting Demons," *Journal of Business Education* (1932), Vol. VII, pp. 18–19.

2. *Sequence errors by superior first-year typists.* Speeding alongside for final honors in this state contest have also been 79 of the best *first-year* typing students from high schools of Washington. All have typed their fastest for fifteen minutes. They have averaged 28 errors per student for the usual penalty of 1400 strokes. This is a loss of 19 words per minute, which is only 2 words behind the second-year contestants. Should you be content to have 2 words per minute represent your gain in accuracy from a second year of high-school training?

These first-year students have made 1052 errors on most-used words. Just where have the errors been? Doubtless you are no longer surprised to learn that 438 have been on the simplest, most common 50 words known. More than half of these typing errors (52%) have been made in the first 100 words of the Ayres list. It may perplex you to observe these first-year students escaping with a slightly smaller per cent of error on the simplest 50 words than the second-year typists have.

3. *Sequence errors of first-quarter typists.* You are now ready for a more exhaustive check on sequence errors. All words mistyped from the first eighteen assignments of a manual have been counted. This has meant 3000 pages of material from 47 first-quarter college typing students. At the head of the error list has stood the word *the* with 298 false strokes. There have been 9414 errors heaped up

on the 1000 most common words. Again a relatively small number of word sequences, frequently typed to be sure, has been responsible for a large portion of all typewriting errors. Do you reread down the columns of Table XXXVII how quickly the errors drop away as a word is less used? how overwhelmingly the errors are massed upon the simple, easily spelled, yet most-used words?

Now that you have read the demonstration of the fact that a large proportion of typewriting errors is made in a few most common words, ponder this unexpected result:

Whereas the low-speed college beginners during eight weeks of practice have piled up 28% of these errors on the first 50 everyday words of the Ayres list, the second-year students, already typing in excess of 50 words a minute, have actually heaped up 44% of like errors. The proportion of errors on this small number of most common words has *not* decreased with practice. As you note from Table XXXVII, this proportion of errors has increased, after eight weeks, one year, and two years of training, from 28% to 41% to 44%, respectively. On the first 300 most common words the proportion has increased from 67% to 73% to 77%, respectively.

Utilizing this statistical "microscope" for sharper details in Table XXXVIII, you will observe that the second-year contestants, with their two years of training and superior speed, actually made more errors than the first-year typists did on the first 5 words, 10 words, and 25 words of the Ayres list. This slight but repeated rise on these ultrafamiliar words presents close to 19%, 27%, and 38% of most words typed in the most ordinary prose. Is there a serious handicap apparent to you? Suppose you compare the average errors on even the first 250 most common words. After one year of training, as shown in Table XXXVIII, the contestants have averaged 9.2 errors per student; after two years of training, 8.8 errors. This is discarding only 0.35 error. Otherwise stated, this is a 4% increase in accuracy on words representing 73% of most commonly typed material. It seems a small return from an additional year of practice. Doesn't this suggest to you that neither these superior students nor their teachers have ever taken the first step of locating the frequent word sequences in which errors intruded?

TABLE XXXVII

THE FREQUENCY OF 11,484 TYPEWRITING ERRORS MADE BY 47 FIRST-SEMESTER COLLEGE STUDENTS, 79 SUPERIOR FIRST-YEAR AND 84 SUPERIOR SECOND-YEAR HIGH-SCHOOL STUDENTS, ON EACH UNIT OF 50 WORDS IN THE AYRES LIST [56]

Cumulative totals of 50 word units of the Ayres list, arranged in order of decreasing frequency of use	Number of errors on each successive unit of 50 words, decreasing in common usage			Per cent of total errors on common words made in each unit of 50 words		
	First-semester College Students	First-year High-school Students	Second-year High-school Students	First-semester College Students	First-year High-school Students	Second-year High-school Students
50	2680	438	453	28.5	41.6	44.5
100	1405	111	120	14.9	10.5	11.8
150	844	62	44	9.0	6.0	4.3
200	609	58	72	6.4	5.5	7.0
250	422	60	57	4.5	5.7	5.7
300	421	46	41	4.5	4.4	4.0
350	324	32	15	3.4	3.0	1.4
400	321	38	32	3.4	3.6	3.1
450	302	32	33	3.2	3.0	3.3
500	258	24	10	2.7	2.3	1.0
550	301	30	28	3.2	2.9	2.8
600	218	11	10	2.4	1.0	1.0
650	204	21	21	2.2	2.0	2.0
700	219	9	11	2.3	.9	1.0
750	196	28	23	2.0	2.6	2.3
800	150	14	11	1.6	1.4	1.1
850	112	11	20	1.2	1.0	2.0
900	186	17	14	2.0	1.7	1.4
950	112	5	2	1.2	.4	.2
1000	130	5	1	1.4	.5	.1
Totals	9414	1052	1018	100.0	100.0	100.0

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[56] Dvorak, A. and Ford, G. C., "The Growth of Typewriting Speed and Accuracy," *Balance Sheet* (1932), Vol. XIV, pp. 66–68.

TABLE XXXVIII

THE FREQUENCY OF ERRORS MADE BY 79 FIRST-YEAR AND 84 SECOND-YEAR HIGH-SCHOOL STUDENTS ON THE FIRST 250 MOST-USED WORDS OF THE AYRES LIST IN THE 15-MINUTE CONTEST COPY [57]

Cumulative total of words arranged in an order of decreasing common usage	Number of words actually found in contest copy	Errors		Average Errors		Average decrease in number of errors made by second-year students
		By 79 First-year Students	By 84 Second-year Students	Per First-year Student	Per Second-year Student	
5	5	149	165	1.8	1.9	− .08
10	10	201	235	2.5	2.8	− .25
25	23	292	326	3.6	3.8	− .20
50	47	438	453	5.5	5.3	+ .15
100	84	549	573	6.9	6.8	+ .12
150	109	611	617	7.7	7.3	+ .39
200	133	669	689	8.4	8.2	+ .26
250	150	727	746	9.2	8.8	+ .35

4. *Routine extinction of errors.* Are you already wedded to the practice of the four simple rules that follow?

(1) Utilize the available facts on the most frequently used English words. Among well-known lists now used in improving your spelling or commercial usage are word counts by Ayres,[58] Horn,[59] and Thorndike.[60] The Shaw-Walker Company has likewise listed names and places most frequently used in business, such as *Smith* and *Jones* and *New York.*

(2) Utilize the available facts concerning the ordinary words most frequently mistyped.

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[57] Dvorak and Ford, *ibid.*

[58] Ayres, L. P., *Measurement of Ability in Spelling* (Russell Sage Foundation, 1915), pp. 12–20.

[59] Horn, Ernest, "The 3009 Commonest Words Used in Adult Writing," *Fourth Yearbook,* Department of Superintendence (National Education Association, 1926), pp. 145–172.

[60] Thorndike, E. L., *A Teacher's Word Book of the 20,000 Words Found Most Frequently and Widely in General Reading for Children and Young People* (Teachers College, Columbia University, 1931).

(3) Utilize the available facts concerning the words which present the greatest difficulties to most students of typewriting.

(4) Use words in natural sentence context as soon as possible.

THE "TYPEWRITING DEMONS"[61–62]

1. *Coefficient of typewriting difficulty.* In studying your errors, you will take into account how often the word is used in your copy and how often there is such interference that the word is mistyped. Thus, a word typed correctly 90 times and mistyped 10 times seems to suffer interference 10% of the time it occurs. A word typed correctly 10 times and mistyped 10 times seems to suffer interference 50% of the time it occurs. To take account of the wide gaps between actual usage of a word and its number of errors, the expression *coefficient of typewriting difficulty* is applied. After all, the number of times a word is mistyped is the number of corrections which must be made. Yet the proportion of these errors to its actual use reveals its relative difficulty.

2. *List of 300 "typewriting demons."* The 300 word sequences *most often mistyped* on the "universal" keyboard have been gathered into a list of "typewriting demons" (Table XXXIX, page 374). The combined errors on these demons amount to 7000, or 75% of all typing errors found in this study on the 1000 common words. In fact, 100 words alone account for 4100 errors, while 200 words account for 6000 errors of this error slag heap. Accordingly, if correctly typed, the 100 typewriting demons would have reduced errors on common words by 45%; the 200 demons, by 60%; the 300 demons, by 75%. Indeed, a mere fifteen words typed correctly — *the, to, and, of, is, which, it, that, for, with, when, have, be, would, will* — would have killed off 17% of these usual errors.

3. *How to use the "demon" list.* As a first step in understanding your own typewriting errors, type your own list of these "typewriting demons" and check your errors against it. Uncover your own total of errors on each of these words.

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[61] Ford, G. C., *op. cit.*

[62] Dvorak, A. and Ford, G. C., "Typewriting Demons," *op. cit.*

TABLE XXXIX

300 "TYPEWRITING DEMONS" ON THE "UNIVERSAL" KEYBOARD [63–64]

(Use index precedes the word, error index follows it.)

5	a	
3	about	
	account	2
	across	3
	act	2
3	after	
	again	
2	all	
2	also	2
	always	
	among	3
3	an	
5	and	
2	another	
3	any	
2	anything	
4	are	2
5	as	
4	at	
2	away	2
	back	
5	be	
	because	3
	become	3
4	been	
2	before	
	beg	4
	began	5
	begin	5
	beginning	3
	begun	3
	behind	4
2	believe	
	beside	5
	best	2
	big	2
	board	
	body	2
	burn	3
	business	3
4	but	
	buy	3
4	by	
3	can	
2	cannot	
	certain	2
	character	2
	check	4
	chief	5
	child	
	close	4
	combination	3
3	could	
3	country	
2	course	
	cover	2
	dark	2
2	day	
4	dear	
	debate	4
	difference	2
	divide	3
3	do	3
	does	2
	done	5
	doubt	5
2	down	
	dozen	3
	during	
	duty	4
	early	2
	education	3
	effect	5
	effort	5
	eight	3
	end	2
	entire	5
2	even	
	event	3
2	ever	2
2	every	3
	experience	5
	extra	4
	far	
	February	3
2	feel	
	felt	3
	few	
2	find	2
	fine	
2	first	
	flight	4
5	for	
	form	2
2	found	2
4	from	
	game	2
2	get	
2	give	2
2	glad	
3	go	
3	good	3
2	great	3
	ground	2
4	had	
	hall	
	hand	2
4	has	
5	have	2
4	he	
	heard	2
	heart	5
2	help	
3	here	
	high	2
3	him	
	himself	2
4	his	
2	house	
2	how	
	however	2
	human	3
	hurt	5
5	I	
4	if	
	important	4
5	in	
2	into	
5	is	3
5	it	2
3	its	
	judge	3
	judgment	3
2	just	
2	kind	
	knew	
2	know	
	large	3
	learn	2
	least	3
3	letter	
	life	2
	light	2
2	like	3
	list	3
2	little	
	live	
2	long	
2	look	2
3	lost	
2	love	
	madam	
2	made	
2	make	
2	man	
2	many	2
3	may	
	meant	
	member	2
3	might	
3	more	
2	most	
2	much	
2	must	3
4	my	
	name	2
	nearly	2
	necessary	4
	neither	2
2	never	4
2	next	
	night	2
	nine	
3	no	
	nor	2
5	not	
2	nothing	
2	number	2
5	of	
	often	2
2	old	
4	on	
2	once	
4	one	
2	only	2

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[63] Ford, G. C., *op. cit.*

[64] Dvorak, A. and Ford, G. C., "Typewriting Demons," *op. cit.* See Appendix, page 503, for "Demon List on Simplified Keyboard."

3	or	
	order	
	organize	5
3	other	
3	our	
3	out	
2	over	
2	own	
	past	2
2	people	3
	perfect	4
	person	3
2	place	2
	power	5
	progress	3
	public	2
2	put	
	question	
	quite	
	refer	2
	remember	2
	reply	2
	return	2
	ride	3
	right	
	river	3
	run	
2	said	
	same	2
3	say	
2	school	
	seven	
2	shall	
3	should	2
2	since	
	small	3
4	so	
3	some	
	sometimes	3
	speak	3
	stand	2
	start	
2	street	
	subject	2
	success	3
2	such	
	supply	2
2	sure	
3	take	2
	talk	
	ten	3
3	than	2
3	thank	5
5	that	
5	the	
3	their	3
3	them	
	themselves	4
2	then	2
3	there	2
2	these	2
4	they	
	thing	2
3	think	2
	third	5
4	this	
2	thorough	
2	those	4
	thought	
2	three	
3	time	2
5	to	2
	told	5
	trouble	3
	true	2
3	truly	
	try	3
	turn	5
3	two	
	under	
3	up	
	upon	2
4	very	
	wait	2
2	want	
5	was	
	water	3
2	way	
4	we	
3	week	
2	well	2
	went	2
4	were	
3	what	2
3	when	5
2	where	
4	which	5
2	while	2
3	who	
	whole	2
5	will	
2	wish	
5	with	
	without	
	woman	
	word	4
2	work	5
	world	5
	worth	2
3	would	3
3	write	3
2	year	
2	yet	
5	you	
5	your	

Then if you want to emphasize the piling up of your errors on a word *because it is used so often*, study the word's "special-attention value from excessive *use*" in the tables from which the list above was made.[65] If many of your errors fall against words having high values from "excessive use," you may realize at once that this is the explanation. Perhaps it should be added, parenthetically, that the most frequent 20 words in this list of 300 typewriting demons are given a weighted value of 5; the next 22 words, of 4; the next 42 words, of 3; and the next 74 words, of 2. None of the 142 less frequent demons are weighted.

In order to emphasize possible piling up of your errors on the *more difficult* word sequences, study each incorrect word's "special-attention value from excessive *error*" as given in the tables cited above. Indeed, if most of your errors fall against words having high values from "excessive error," you may realize at once that an awkward stroking pattern is the explanation. If errors tend to match the extent of the word's use, the word is not so weighted. If the word is about twice as likely to be mistyped, it is weighted 2 times; if three times as apt, 3 times; if four times, 4 times; if five to nine times as likely to be mistyped, 5 times.

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[65] See Dvorak, A. and Ford, G. C., "The Growth of Typewriting Speed and Accuracy," *Balance Sheet* (1932), Vol. XIV, pp. 66–68.

This weighting is outlined merely to help you understand the *coefficients of typewriting difficulty.* If the typewriting demon's coefficient is 1.00, then the number of errors quite balances the extent the word is used. If the coefficient drops below 1.00, then there is less error and the pattern is more efficiently typed than you would expect from its usage. In words with very low coefficients, such as *on* with a .20 or *not* with a .27, the mounting errors are due to the tremendous employment of such a word in English copy. On the other hand, if the coefficient rises above 1.00, then there is more error and the pattern is less efficiently typed than you would expect from its usage. If the coefficient is 2.00, the word is twice as apt to be mistyped. This is roughly true of 75 "demons" with coefficients running between 1.50 and 2.49 in difficulty. If the coefficient is 4.00, the word is four times as apt to be mistyped; if 5.00, then five times. Hardly more than a score of the "demons" reach the latter difficulty. In short, the higher the coefficient, the more difficult it appears to typewrite the word sequence correctly.

If you are ever inclined to think of errors in terms of hapless fingers rather than "demon" words, glance at the coefficients of *began, doubt, effort, experience, organize,* and *turn.*

The list of "typewriting demons" on the "universal" keyboard will also serve as a reminder that many of the exceedingly frequent words on which you pile so many errors are not difficult patterns. Of 158 words weighted for "excessive usage," only 44 are also weighted for "excessive error." Extreme samples of inaccuracy, as in *which* and *when,* are more than matched by extreme samples of accuracy, as in the sequences *dear* or *not* or *week.* The average coefficient of difficulty for the 75 words of heaviest occurrence in English prose is .85, which is reassuring in the face of the general keyboard pattern.

THE MOST-USED DIGRAPHS

1. *The Yardley sequence count.* You have discovered that certain common sequences may play an unexpected part in your typewriting misbehavior (unpopularly known as *errors*). Lessenberry[66] has given a marked impetus to this direct assault on typing errors by issuing a widely circulated chart showing most common two-letter sequences. It is essential that your own definite location of errors be made in the light of such a series. Owing to the method used in recounting 3000 most common words in the Horn[67] list, the amounts are inexact and often out of line. You will see this at a glance if you compare the relative occurrence of each dominant combination in the more correct count by Yardley.[68]

TABLE XL

THE FIRST THIRTY HIGH-FREQUENCY DIGRAPHS IN THE YARDLEY[69] COUNT AND IN THE LESSENBERRY[70] RECOUNT FROM THE HORN LIST

	Relative Occurrence														
Digraph	th	er	on	an	re	he	in	ed	nd	ha	at	en	es	of	or
Yardley	50	40	39	38	36	33	31	30	30	26	25	25	25	25	25
Lessenberry	13	37	33	22	42	14	50	35	15	9	23	31	30	2	20
Digraph	nt	ea	ti	to	it	st	io	le	is	ou	ar	as	de	rt	ve
Yardley	24	22	22	22	20	20	18	18	17	17	16	16	16	16	16
Lessenberry	22	18	26	7	16	24	16	21	13	14	22	10	17	9	16

2. *The Ostrey and Rowe sequence counts.* That Lessenberry was well aware of this gap is evident in the correct count that soon appeared from the University of Pittsburgh. This new list, from

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[66] Lessenberry, D. D., "Chart Showing All Two-Letter Sequences Based on an Analysis of the Horn 3009 Commonest Words" (L. C. Smith and Corona Typewriters, Inc., Syracuse, New York).

[67] Horn, Ernest, "A Basic Writing Vocabulary, 10,000 Words Most Commonly Used in Writing," Monographs in Education, First Series, No. 4 (University of Iowa, 1926).

[68] Yardley, H. O., "Cryptograms and Their Solution," *The Saturday Evening Post* (November 21, 1931), pp. 21, 63–65.

[69] *Ibid.*

[70] *Op. cit.*

Rowe,[71] becomes a kind of measuring rod with which you estimate the intensity of any common two-letter digraphs involved in your repeated typing errors. Table XLI brings out each common digraph — from lesser up to overwhelming intensities of the *th* or *he* digraphs. From this you discover how often in your daily typing each digraph, relatively, does occur. In case you find it clearer to use these times that each digraph occurs in copy as per cents instead of as relative numbers, look up Ostrey's [72] more elaborate digraph count, based correctly on the Horn list of 1500 most common words. As with the "typewriting demons," type your own list of used digraphs, but with this difference: Type a column at a time, using plenty of paper and adorning each amount with a bar diagram (made with m or any other character) in this manner:

ab 8 mmmmmmmm
ac 11 mmmmmmmmmmm

In this dramatic, vivid fashion you will be startled at the dominating intensity of certain digraphs. Your bar diagrams will be distinctly more clear-cut than the figures. You will see the more powerful typing combinations emerge as more and more distinct forms against the clutter of their infrequent and far less noteworthy companions.

THE PLANNED ATTACK ON SEQUENCE ERRORS

1. *Proofreading and counting errors.* It will be unnecessary to check your own errors against these common digraphs. Your direct interests are, first, in making common word patterns automatic and, second, in avoiding any unnecessary classroom motions known as "red tape." Whatever record sheet you use for a systematic check of your errors, however, can automatically classify today's errors *while you make the count of net words typed.* You may wish to do this

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[71] Rowe, C. E., "Importance of Two, Three, Four and Five Letter Combinations on the Basis of Frequency in a Word List," Master's Thesis (University of Pittsburgh, 1930). Also in *Research Bulletin in Commercial Education* (New York University, 1930), Vol. II, pp. 7–12.

[72] Ostrey, J. M., "A Critical Analysis of Letter Sequences in Typewriting," Master's Thesis (University of Nebraska, 1929), pp. 208–221.

TABLE XLI

List and Relative Occurrence * of Digraphs Based on an Analysis of the Horn 1000 Commonest Words

(From Rowe [73])

Sequence	Stress	Sequence	Stress	Sequence	Stress	Sequence	Stress	Sequence	Stress
ab	8	ef	5	ip	3	of	35	si	13
ac	11	eg	3	ir	9	oi	3	sk	1
ad	19	ei	9	is	40	ok	3	so	21
af	3	ek	1	it	48	ol	7	sp	1
ag	4	el	13	iv	8	om	23	ss	7
ai	7	em	10	ju	5	on	44	st	31
ak	6	en	43	ke	9	oo	15	su	7
al	29	eo	1	ki	5	op	7	sw	1
am	12	ep	5	kn	5	or	51	ta	10
an	90	eq	1	ks	1	os	8	te	38
ap	4	er	85	la	12	ot	26	th	144
ar	41	es	21	ld	14	ou	98	ti	24
as	39	et	27	le	28	ov	6	tl	3
at	54	ev	8	lf	1	ow	19	to	59
au	1	ew	5	li	11	oy	1	tr	5
av	21	ex	4	ll	40	o-	1	ts	1
aw	1	ey	6	lo	11	pa	8	tt	16
ay	21	fa	4	ls	2	pe	9	tu	5
ba	4	fe	6	lu	1	pi	1	tw	2
be	34	ff	3	lw	1	pl	11	ty	3
bi	2	fi	7	ly	13	pm	1	ub	1
bl	5	fo	27	ma	18	po	6	uc	6
bo	10	fr	9	mb	2	pp	4	ue	3
bu	12	ft	3	me	40	pr	8	ug	4
by	4	fu	4	mi	4	pt	3	ui	2
ca	17	ga	4	mm	1	pu	2	ul	13
cc	2	ge	13	mo	10	py	1	um	1
ce	22	gh	9	mp	3	qu	3	un	11
ch	20	gi	5	mr	2	ra	5	up	6
ci	3	gl	2	ms	1	rc	1	ur	42
ck	4	go	14	mu	6	rd	12	us	20
cl	4	gr	2	my	8	re	77	ut	23
co	21	gu	1	na	2	rg	1	va	1
cr	1	ha	66	nc	9	ri	13	ve	51
ct	6	he	117	nd	72	rk	2	vi	5
cu	1	hi	35	ne	23	rl	2	vo	1
da	11	ho	20	nf	1	rm	2	wa	16
dd	1	hr	2	ng	33	rn	5	we	37
de	18	ht	5	ni	7	ro	14	wh	19
di	11	ia	2	nk	5	rr	3	wi	32
dl	2	ib	1	nl	2	rs	12	wn	2
do	11	ic	12	nn	2	rt	7	wo	12
dr	1	id	8	no	32	ru	2	wr	4
ds	1	ie	4	ns	4	rv	1	xp	1
du	1	if	11	nt	24	rw	1	xt	1
dv	2	ig	6	nu	1	ry	15	ye	4
dy	1	ik	2	ny	8	r.	1	yo	57
ea	25	il	23	n'	3	sa	10	ys	3
ec	16	im	11	ob	1	sc	2	yt	1
ed	20	in	81	oc	1	se	36	't	3
ee	20	io	9	od	5	sh	16	-d	1
								Total 3375 *	

* Last four figures omitted. Total frequency of all digraphs: 36,941,972.

[73] *Op. cit.*

by separating errors into "types," such as "substitutions," "omissions," "transpositions," "insertions," and various faulty "manipulations." If you are not already overfamiliar from sad experience with these varieties of false strokes and other misplays, each will shortly be accorded a brief sketch.[74] In this way, by a single proofreading all errors are listed as "types" and you are ready to deduct 10 words from your gross copy for each error, until your final net-words-per-minute is reached. As you follow the International Contest rules and circle all errors on your typed sheets, note Crosland's [75] dividing line between proofreading errors. On the one side are errors easily caught, which stand out distinctly from other details of your writing. On the other side are errors missed with surprising regularity, which seem to vanish unnoticed in the other details. Do you notice this distinction in counting (with some inevitable incompleteness) your own typing errors? The error-count summary of your proofreading might follow some such order as this:

MOTION STUDY OF EXCESSIVE ACTION

	ASSIGNED UNITS									
PRODUCTION	1	2	3	4	5	6	7	8	9	10
Total Lines										
Total Accurate Lines										
Total Inaccurate Lines										
INDICATORS (ERRORS)										
Capitalization										
Punctuation Marks										
Numbers										
Symbols										
Abbreviation										
Word Division										
Word Omitted										
Transposed										
Substituted										
Inserted										
Repeated										

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[74] See pp. 384–394.

[75] Crosland, H. R., "An Investigation of Proofreaders' Illusions," *University of Oregon Publication* (University of Oregon, 1924), Vol. II, No. 6.

- Sequence Errors
  - Spelling
  - Typing Demons
  - Idioms
  - Serial Stroke
    - Omitted
    - Transposed
    - Substituted
    - Inserted
    - Repeated ____________________
  - Space-bar Stroke ____________________
- TOTAL ERRORS ____________________
- NET WORDS PER MINUTE ____________________

Every five lessons check:

- AVOIDABLE DELAYS
  - Paper Insertion ____________________
  - Paper Release ____________________
  - Carriage Throw ____________________
  - Margin ____________________
  - Tabulation ____________________
  - Back Spacing ____________________
  - Erasure ____________________
  - Lines Recopied ____________________
- RELAXATION FAILURE
  - Felt Tenseness or Felt Fatigue
  - (*a*) In Ballistic Stroking ____________________
  - (*b*) In Posture
  - (From what muscle groups?)[76] ____________________
- RHYTHM FAILURE
  - Uneven Imprinting
  - Felt Breaks

Ever since the first week of your typing practice you have gradually met, one after another, many varieties of errors. Although you have started in early to count these errors, the accuracy of your typed lines has hardly mattered at the outset. In fact, to have tried to be "slow but sure" would have ruined the early growth of your typing form at its start. Yet you should have commenced to collect errors, to spot "demon" errors that have come again and again, and to practice lines in which they have happened. Just as you now prefer to find your own error demons, probably you have also been doing your own thinking about such errors for some time. An error is a delay. An error is not only a wasted motion; it interrupts, if only for a moment, the typing of your line. For some weeks it has probably been obvious that you cannot afford even the slightest delays if you are to type with less and less effort in less and less time.

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[76] See pp. 84–101.

If you suffer from a run of errors or feel baffled by a typing problem, your first step is to name and face this trouble. More important than your mere counts of errors is your noting down of regular errors that recur. This is the first step when a real study of underlying difficulties seems necessary. A sample record sheet for such learning difficulties has already been issued by Lessenberry.[77] Utilize such suggestions while forming your own list of "pet" typing troubles:

Is it that you do not quite understand "paper guide, marginal stops, line-space regulator, tabular stops, paper release, carriage release, margin release"?

Do you need help with certain "key strokes, the space-bar stroke, shifting for capitals"?

Do you have trouble with "writing rhythmically and accurately, keeping up with class dictation, keeping eyes on copy, curving fingers, individual finger control, wrist motion"? [78]

2. *A technique check list.* The chances are high that a typed error is not in the machine. The chances are high that this error is in you. Often it pays more dividends to check the positive things that you are doing rather than to worry over your errors and their possible causes. All causes thus far described definitely by typing experts simply picture the reverse, negative side of good technique.[79] You have done, to put it bluntly, the opposite of what you should do — to remedy the error. With certain errors the cause is at once obvious. If you are slow in releasing keys or the space bar, for instance, naturally you expect to find some shadow letters, some capitals cut off

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[77] Lessenberry, D. D., "Administration and Supervision of Shorthand and Typewriting in the Junior and Senior High Schools," *Third Yearbook* (Eastern Commercial Teachers Association, 1930), p. 108.

[78] Lessenberry, *ibid.*, "Writing Difficulties."

[79] Note, for instance, the table for error analysis in Smith, H. H., "The Teaching of Typewriting," *American Shorthand Teacher* (1931), Vol. XI, pp. 210–211.

or toppled above the line, or too many spaces left between some words. Really it is simpler to prevent errors by becoming more skillful. A study less of errors and more of yourself, holding an excellent posture, breathing evenly, using correct muscles and motions, with just the right effort, rhythm, and timing, is as easily made. It is more pleasant to see errors drop away than to try to find out why they ever happened. The causes of many errors, moreover, may be uncertain or quite accidental, or they may spring from feelings in yourself too complicated to unravel in a short study. Unless you are making many errors, it is hardly needful to harp on carelessness and faulty motions and copy that is "misread, half read, reread, unread."

Have you ever taken the trouble to set down the chief features of balanced posture, of *ballistic* stroking, of smooth motions to other machine bars, levers, keys, or of your best rhythmic pace? Actual check lists should serve as occasional reminders of pointers already featured to improve the class typing. These definite items of good technique can be finely worked up as class projects. Any check list should remain concrete, with such definite items as "Wrist quiet?" "Thumb close to index finger?" "Fingers hovering closely over keys?" "Fingers up (middle joints above home row)?" "Natural hand-finger arch?" until *ballistic* stroking is thoroughly covered in this list; and with such definite items as "Body balanced from the hips?" "Lower back firm?" "Chest up?" "Straight line from neck to base of spine?" "Straight line from elbow to joints between hand and fingers?" until *balanced posture* is thoroughly covered. Utilize an expert's observation chart as your starting point, to build up a similar check list of items that you want to accomplish. Here are typical items from a Lessenberry[80] chart with which your typing instructor can help you correct flaws in otherwise good form:

I. Position at the Typewriter
    A. Body: Sit nearer the typewriter. Sit away from the typewriter. Lean from the hips toward the typewriter. Shoulders erect. Feet on the floor. Body well balanced. Body relaxed, but not sagging.
    C. Wrists: Lower the wrists. Raise the wrists.
    D. Fingers: Curve the fingers more. Fingers curved too much.

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[80] *Op. cit.*, pp. 106–107.

II. Operating Technique
   C. Key stroke: Use the snatch stroke (do not punch the keys). Touch must be more even. Use a lighter stroke (quick getaway). Incorrect fingering. Use a more forceful stroke (well-controlled). Do not raise the fingers so high. Relax the muscles of shoulder, forearm, wrists.[81]

Adapt hints such as the following from the quick typing checkup arranged by Skene:[82]

Are you still cutting down the movements by your hands and arms?

Do you type at your best rate in regular rhythm, so that you avoid striking some letter too lightly or omitting it, or crowding and piling up other letters? Are your fingernails rounded with the finger tips so that each finger can be curved while striking?

Do you read less than two words ahead of your typing fingers?[83]

Match your typewriting each week against your own check list of essential items, to catch suggestions afresh and notice what you still omit to do. Doesn't this add interest to typing studies?[84] Isn't this a more intelligent way to study than monotonous drilling of some unfortunate word that you have happened to mistype?

MACHINE ERRORS IN TYPING

1. *Rowe list of nonletter errors.* As you take these first steps toward the improvement of your typewriting misbehavior by observing and carefully charting repeated signs of trouble, particularly "typewriting demons," you will discover with Rowe[85] that one fifth of your errors are in nonletter motions made on your machine.

In Pittsburgh typing classes a majority of these 52 nonletter errors are also made during more than 10% of the classroom time. Here is an added guide for charting your path through differing aspects of typing misbehavior.

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[81] Lessenberry, *ibid.*, "Technique Check Sheet."

[82] Skene, E. C., "Remedial Teaching of Typewriting," *Second Yearbook* (Commercial Education Association of New York City and Vicinity, 1932), pp. 69–81.

[83] *Ibid.*

[84] See also Breidenbaugh, V. E. and Ehrenhardt, I., *Interesting Things in the Teaching of Typewriting* (Prentice-Hall, 1932).

[85] Rowe, C. E., "Correcting Non-Letter Errors in Typewriting," *Journal of Business Education* (1931), Vol. V., pp. 30–31.

TABLE XLII

ICY OF 2118 NONLETTER TYPEWRITING ERRORS, WITH PER CENT OF INACCURACY AND RELATIVE DIFFICULTY
(From Rowe [86])

Nonletter Error	Number of Errors	Per Cent of Inaccuracy	Special-attention Values
ing the Carriage			
Wrong finger position . .	68	32	4 ×
Pushing instead of throwing	64	30	4 ×
Whole arm used instead of forearm	55	26	3 ×
Looking away from copy when throwing carriage .	63	29	4 ×
Throwing carriage too hard (so that writing begins to the left of the margin) .	15	7	
Throwing carriage too lightly	11	5	
ting the Carriage			
Misreading carriage-frame pointer on scale . . .	91	42	5 ×
Using space bar instead of carriage-release lever . .	16	7	
Using carriage release instead of space bar . .	82	38	5 ×
Wrong finger position on left carriage-release lever	34	16	4 ×
Wrong finger position on right carriage-release lever	43	20	3 ×
Does not know the number of line spaces to an inch	110	51	5 ×
ting Paper			
Does not hold paper correctly for insertion . .	42	20	2 ×
Does not place paper against paper guide . .	11	5	
Does not "twirl" cylinder knob	77	36	4 ×

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[86] *Ibid.*

TABLE XLII — *Continued*

Nonletter Error	Number of Errors	Per Cent of Inaccuracy	Special-attention Values
16. Removes paper without using paper-release lever	24	11	
17. Does not know how to use paper-release lever in adjusting paper . . .	29	13	
18. Does not know how to move paper guide . .	33	15	
19. Does not know position of paper guide to center the paper	21	10	
20. Uses wrong cylinder knob to move paper vertically	37	17	2 ×
21. Does not know the number of "clicks" to an inch .	49	23	3 ×
22. Paper clamps not over the paper	24	11	
23. Paper clamps too far over the edges of the paper .	43	20	3 ×
24. Cannot center the paper .	42	20	2 ×
25. Cannot adjust for point of writing (with variable line spacer and the like)	130	60	5 ×
Spacing on the Page, Vertical and Horizontal			
26. Wrong number of spaces from the top of the paper	37	17	2 ×
27. Wrong number of spaces between lines	22	10	
28. Does not know how to move marginal stops . .	10	5	
29. Cannot adjust marginal stops	2	1	
30. Cannot figure centering .	110	51	5 ×
31. Does not know number of vertical spaces to inch .	46	21	3 ×
32. Does not know number of horizontal spaces to inch	70	33	4 ×

TABLE XLII — *Continued*

Nonletter Error	Number of Errors	Per Cent of Inaccuracy	Special-attention Values
33. Does not hear the bell	52	24	3 ×
34. Cannot operate marginal release controlling right margin	26	12	
35. Moves marginal stop instead of using left marginal release	72	33	4 ×
Operation of Shift Key and Lock			
36. Moves hand out of position	36	17	2 ×
37. Wrong finger on key	4	2	
38. Looks at key	8	4	
39. Release of shift before striking letter key	16	7	
40. Letter-key release too slow	8	4	
Backspace Key			
41. Moves hand out of position	111	52	5 ×
42. Wrong finger on key	64	30	4 ×
43. Looks at key	86	40	5 ×
Tabular Key			
44. Strikes key instead of holding it	15	7	
45. Moves hand out of position	43	20	3 ×
46. Looks at tabular key	37	17	2 ×
47. Wrong finger on key	17	8	
48. Does not know the use of this key	1	0.5	
Tabular Stops			
49. Misreads tabular scale	25	12	
50. Cannot adjust tabular stops	9	4	
Space Bar			
51. Release too slow (typewriter jumps a space)	1	0.5	
52. Does not bend thumb but keeps it straight and moves whole hand	56	26	3 ×

At definite intervals check your own machine errors against this list (Table XLII) with its more than 2000 items of incomplete adjustment to typewriting. Do most of your errors fall against items bearing the heavier weights, such as 4 × and 5 × ? This definite location of difficulties remains your first move in thinking out your plans for improvement.

2. *Check list of machine technique.* At this point you are able to extend your own check list of essential items to cover all manipulation in the typing cycle. Study the positive use of each machine part rather than its misuse.[87] Build up concretely a personal check list of positive points that offset the errors.[88] These items can be illustrated by the following hints adapted from the quick typing checkup planned by Skene:[89]

Is your paper guide in position? Do you hold the edge of the new sheet flush with the paper guide? Do you carry this paper swiftly in with its center nicely at 40? Is this paper twirled in at least an inch each time, with your right thumb under and first two fingers on top of the knob?

Do you understand the problem of centering a block of typing on a page?

Does your shifting fit into your writing rhythm? As you shift, is your getaway from the letter key fast enough to avoid blurring or cutting off a letter?

Does your spacing between words catch the regular writing rhythm? Are wrist and hand in such a position that the space bar is struck, but never the machine frame? Do you space with the side of a loosely bent thumb? Is your thumb's getaway always fast enough to avoid skipping a space?

Do you hear the bell and end your line without looking at your typescript? Are you able to divide words correctly? Are your right margins even?

After ending the line, is your carriage throw just hard enough to reach the margin? Are your eyes always on the copy as you throw?

Do you hold the tabular key down firmly until it clicks? Do you strike this key in its center?

Do you use the nearest finger and keep your hand in position when stroking the backspacer? Do you keep your eyes on the copy?

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[87] For further defining of these terms and their positive uses, see Morton, A. E., *Questions and Answers on Typewriting and Office Procedure* (Sir Isaac Pitman and Sons, 1928).

[88] See Rowe, C. E., "Corrective Procedures for Wrong Typewriter Manipulation," *Fifth Yearbook* (Eastern Commercial Teachers Association, 1932), pp. 180–185.

[89] *Op. cit.*

When the paper slips somewhat as you move it up to correct an error, can you adjust back again to your line of typing? Can you use the line scale for this with the paper release open? Can you use the variable line spacer to get back to a given line? Do you have your paper release locked while you use the variable spacer?[90-91]

INTERFERENCE WITH TYPING ADJUSTMENT

Are you now set for an incisive summary by Wells,[92] which will also throw the bulk of your typing errors into the usual classes? Against a lesser background of early minor experiments, wherein psychologists mostly toyed with quite amateurish "learning curves" first, Book has finished his admirable typing study [93] and Wells has also gone straight to the heart of typing adjustment in his brief experiment. This psychologist has worked with two advanced typists in a practical emphasis on faulty adjustments — errors. Sequence blocking has been plotted and timed, using electric circuits operating signal magnets whenever a key or a space bar has been struck.

1. *Special cases: excessive action of beginner typists.* First let certain errors be decisively set apart. Let these be the slow errors which you have experienced as a beginner typist engaged in hunting reaches on an unfamiliar keyboard. Such initial behavior is neatly decried in one word — "excessive." [94] It is akin to "mass" action by too many muscles. As these slow misplays gradually drop away, excessive action ceases to intrude so prominently. More refined, partly relaxed patterns are emerging out of so many diffuse trials. While you are in this preliminary stage, increasingly as you have typed certain words, your strokes all have overlapped in a complete sequence. This overlapping between strokes, highly stressed by Peterson,[95] operates to make the complete sequence more compact and

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[90] Skene, *op. cit.*

[91] Turn also to pp. 384–387 of this text.

[92] Wells, F. L., "On the Psychomotor Mechanisms of Typewriting," *American Journal of Psychology* (1916), Vol. XXVII, pp. 47–70.

[93] Book, W. F., *The Psychology of Skill with Special Reference to Its Acquisition in Typewriting*, Studies in Psychology, Vol. I (University of Montana, 1908).

[94] Kuo, Z. Y., "The Nature of Unsuccessful Acts and Their Order of Elimination in Animal Learning," *Journal of Comparative Psychology* (1922), Vol. II, pp. 1–27.

[95] Peterson, Joseph, "A Note on Theories of Learning," *Psychological Bulletin* (1922), Vol. 19, pp. 443–446.

to exclude excessive acts. Inaccurate fumbling strokes at the right keys can now be set aside as too infrequent to worry over. Already you express yourself more completely. Your normal errors now relate to the overlapping between faster strokes in word sequences. Trouble shooting for errors is past the awkward beginner's stage.

2. *Special cases: copy-reading errors.* Let certain other errors also be decisively set apart. Let these be such errors as *admiration* typed for *ambition.* Obviously such a copy-reading error, as distinct from the false stroke in *amvition,* is "outside" any defect in your serial key stroking.[96] All errors are results of interference somewhere that momentarily affects the typing. An omission may follow your eyes' failure to cling to copy. Reading errors, however, may be due to influences quite unrelated to the general run of the typewriting. Foolish typing may follow these accidental, conflicting pulls. A good sample of just such a reswitching of words is given you by Gruenberg[97] from student *Boners.* In a student's examination appeared the sentence: "Esau was a man who wrote fables and sold his copyright for a mess of potash." In addition to the confusion of Esau with Aesop, "birthright" is switched to "copyright" and "pottage" to the high-school chemistry course with its "potash." That such errors are largely due to chance is even more obvious when you compare the word omissions in half your typewritten tests with the word omissions in the other half. Of girl typists in New York high schools,[98] similarly, 94 have omitted words in one half their tests, but not in the other half; 49 have omitted none in the former half of the tests, but some in the latter half. This has left 108 with no word omissions. Obviously there is neither rhyme nor reason there. Omitted, added, or repeated words are chiefly chance results. In the 48 minutes of speed typing by these high-school students, incidentally, the usual girl has six words omitted and two

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[96] Wells, *op. cit.*

[97] Gruenberg, B. C., "Educational Exploitation of Errors," *Educational Method* (1931), Vol. X, pp. 9–16. Also, Abingdon, A., *Boners, More Boners, Still More Boners* (Viking Press, 1931).

[98] Ackerson, Luton, "A Correlational Analysis of Proficiency in Typewriting," *Archives of Psychology* (Columbia University, 1926), Vol. XIII, No. 82.

words added or repeated.[99] Certainly such chance factors have scant relation either to error penalties or to rising speed of stroking.

3. *Effective strokes at wrong keys.* The bulk of your typing errors remain "effective strokes at wrong keys."[100] Evidently this is a matter of central control rather than of finger and forearm muscles. The stroke is effective, but its play for position and direction sends your finger to the wrong key. The actual fault is thus traced back to the slight delay before the stroke. The shorter these delays, you recall, the more stable is your typing of the word.[101] Otherwise a key stroke is perhaps anticipated (omission and transposition), or another key stroke is substituted or added outright (substitution and insertion). On the surface, a key stroke is misplaced within the sequence. Some chance, conflicting interference has pulled a key stroke out of line. The effect, however, is to disrupt the sequence. To this extent the orderly succession of strokes is blocked. In this momentary breakup of a succession that should highly overlap, what you really have is not a "false" stroke but a false digraph. This false digraph is pulled in and the second key stroke perhaps sent to the wrong bank of keys, perhaps inward to a stronger finger or even to the corresponding finger of the other hand. These and other possibilities are very familiar.

Of conflicting pulls, known as interference, that force such errors, however, there are more than the popular fifty-seven varieties. Yet stimulation by the conditioning signals of certain more common sequences doubtless takes front rank. A high-powered digraph, for instance, is derived from frequent, actual use in copy. There s less resistance met in making its actual reaches on the keyboard, as reflected in your own typing tension. This varies from the extremely slow digraphs stroked with the same finger, particularly n difficult hurdles across the home row of the "universal" keyboard, to the less awkward adjacent stroking, the faster play between certain remote fingers, and the increasingly fast, smooth digraphs between fingers on opposite hands. It is possible that high-powered digraphs may disrupt and even displace lesser digraphs. Such interference arising from a more dominant sequence (either a digraph or longer letter combination or common word) thus reflects interference from the copy, from the keyboard, or from your own tension. Whatever the interference, the important result is a "very transitory breakup" in your typing sequence.[102]

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[99] *Ibid.*

[100] Wells, F. L., *op. cit.*

[101] Lepley, W. M., *op. cit.*

4. *Time delays of error blocking.* By timing electric circuits, Wells[103] shows you the actual *blocking* caused by the interference in typing. Now and then there is a slowing of the typewriting for some strokes before the error, as the adjustments gradually fail. Usually the blocking seldom lasts over 1½ seconds. Its time increases when you are tired.[104] Usually the block comes directly after the falsely directed stroke, sometimes not for another stroke. Thus, *fht* for *the* has appeared somewhat slowed, but on the next word considerable delay has arisen. The blocking may even come on the stroke just before the error. Sometimes you are aware of the wrong stroke before it hits the paper and a lighter imprint appears. Sometimes you are aware of the error, and sometimes *not.*

For his two operators, Wells[105] times the usual four classes of errors: substitutions, insertions, omissions, transpositions.

5. *Substitutions and omissions.* Substitutions chiefly noted in this experiment are the usual neighboring key strokes and confused vowels.

The omissions seem chiefly on keys difficult to reach, notably *m* and *n* with these typists. Omitting a step in the complete sequence pattern is confessed by one typist somewhat as follows: "I spell the word mentally, but the fingers travel faster than I can spell it. Sometimes the fingers finish ahead and I come out one letter short."

Omissions due to the anticipation of a somewhat later letter stroke seem easier if the wrong stroke is in the neighborhood of the omitted key. If a stroke is anticipated, it is not repeated when the typing arrives at its proper point in the word *unless* there is a definite block in the typing in between. Such a block is very obvious as soon as the time delays are inserted in the pattern. Thus, *if it* is mistyped as

i (.3 sec.) *t* (.8 sec.) *f it*

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[102] Wells, F. L., *op. cit.*

[103] *Ibid.*

[104] See pp. 399–422 in this text.

[105] *Op. cit.*

6. *Transpositions as errors.* A false anticipation is often felt before its proper place in the word is reached. Obviously, if there is no block, the regular result of anticipating a stroke is its transposition. For example, *engender* is almost never written as *endender* but as *endenger.* As with omissions, this interchange of two strokes within the pattern seems easier between adjacent keys. The interchange may even be between digraphs, as in *unpredijuced* for *unprejudiced.* Moreover, a block does sometimes occur in transpositions, as when *hold* is mistyped *hod* (1 sec.) *l.*

Wells shows further interesting samples, such as transposed doubling, as in *thses* for *these.* Another sample becomes clear-cut when the slowed time of the block is inserted for *tyrannized*, mistyped as

(2.0 sec.) *ty* (.3 sec.) *r* (.3 sec.) *ranized*

7. *Insertions and other dominant-sequence interference.* Instances of interference by dominant word sequences are:

that, mistyped *the* (2 sec.) *t*
spectacle, mistyped *spec* (.4 sec.) *tab* (1.2 sec.) *le*
poet's, mistyped *powe* (.6 sec.) *t* (.3 sec.) ' (.4 sec.) *s*

Here more dominant sequences, such as *the*, *table*, *power*, result in substitution and even addition of strokes. These samples drawn from Wells demonstrate clearly why you should practice sequences rather than isolated letters when you remedy your errors.

Note these more severe breakups of the adjustments, which present all four of the usual classes of error:

For *own heaven*, the sequence *our* has first interfered, with the belated correction *w* and the omission of *n* from the pattern, thus:

ou (.5 sec.) *w* (.4 sec.) Space (2.0 sec.) *heaven*

In typing *obedience* there has been a persistent anticipation of the *c* as the operator has typed *obec* slowly, backspaced once, typed *dic*, backspaced again, and ended on *ecn.* In such severe breakups of the typing adjustments, the writing is distinctly slowed.

From the backspaced strike-overs in this last sample, you may surmise that this unfortunate habit, which the operator seemed trying hard to check, has probably lengthened some error blocks. This habit is called unfortunate because it may take the time of five or six correct strokes. It is the excessive waste of time from erasing or otherwise correcting *very few* errors which raises the cost of final, accurate typewriting outcomes. Although the errors of these two typists have been well under 1% of the total strokings, yet they are heavily penalized because of the wasteful alterations involved.

Do you wonder that this incisive sketch by Wells[106] has remained the basic outline of typing errors for more than a decade? Its only rival is the extensive discussion of errors among students and champion typists in the already classic volume by Book.[107] At least these two psychologists have opened the door for your own careful study of your own errors.

8. *Using new devices to diagnose interference.* The improvement of the typewriting instruction which you receive is now gathering such impetus that new statistical surveys of errors will shortly chart your voyage across the sea of errors as closely as in the chartroom of any ship. Forerunners of these impending studies are the detailed technique check lists to offset sequence and machine errors. Another forerunner of these impending studies is the detailed list of "typewriting demons" furnished you with exact coefficients of difficulty. These coefficients, of course, cease to apply or are altered if you use a "simplified" keyboard.[108] Not only may new and detailed charts guide your correction of errors, but also new and more scientific methods may appear to trace the underlying interference and suggest to you the concrete trouble. In the light of the cumulative changes about to break over the field of typewriting classwork, it is possible that up-to-date "trouble-shooting" materials and methods will soon be available for the coming abandonment of handwriting for personal typing by other students everywhere. Certainly more modern devices are in the offing.

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[106] *Op. cit.*

[107] Book, W. F., "Normal Tendencies to Error," *Learning to Typewrite* (Gregg Publishing Company, 1925), pp. 238–268, 162–163.

[108] See Davis, D. W., "An Analysis of the Simplified Keyboard," *Journal of Business Education*, May, June, September, and October, 1935, for data on the extent to which the "simplified" keyboard, by making typewriting possible with simpler motions, removes much of the interference found on the "universal" keyboard.

INTERPRETATIVE SUMMARY

All preceding discussions of workroom discoveries sustain a positive attitude which holds *correct, fast* typing in the foreground. The emphasis is on correct and not on incorrect motions, on fluency of rhythm and not on hesitations. The extinction of errors should be more or less automatic because elimination of action should go on until no more elimination is possible. The least possible action while typewriting implies dropping false, hence wasteful, motions. Yet directions to "avoid errors," by contrast, may interfere with learning by bringing incorrect, slow typing into the foreground.

Nevertheless, *repeated* errors are interesting items. To unearth the hidden interference beneath each error indicator can be profitable, perhaps entertaining, diversion. Such searching for "causes" of errors and their conquest brings the diagnostic testing movement into typewriting. This will lead to new materials having simpler difficulty levels, made definite by widespread tryouts. As economies cease to be so insistent, such study will be made complete by slow-motion films. With or without such aids, an automatic or repeated error becomes the student's own cue to start thinking, not retyping.

The delusion that students learn to typewrite by mastering an accurate letter stroke leads many to think of errors as false letter strokes. To count isolated letter errors is artificial and fruitless. Typing errors are signs of interference, due partly to drills on isolated letter strokes and nonsense combinations, partly to the relative dominance of common sequence signals, partly to chance slips in technique, and partly to the underlying keyboard arrangement. Trouble is also due partly to other factors. Yet most of the errors remain effective strokes pulled out of their correct line-up in the sequence. In the overlapping between successive strokes, one or another key stroke is anticipated or added or even substituted outright. Its appearance is that of misspelling.

Against this bulk of errors, the chief attack is on the *kind* of delay involved. Here such terms as *irregular*, *excessive*, and *avoidable* contrast sharply with *regular*, *slight*, and *normal* to define delay. It may be stated as a general principle that the wider the delay between strokes in sequence, the higher is the chance of error. This is why isolated-letter and nonsense-syllable practice, by neglecting wide delays between the strokes of common words — in short, by failure to develop the closer overlapping of strokes in common words — becomes a major cause for continuing errors. Such drills may bring continual, irregular interference whenever sentences and common words are attempted. The resulting disappointment is a wet blanket over interest.

Wide, irregular delays invite intrusion of some stroke out of its order. Heavy usage of certain digraphs, for example, creates dominant conditioned patterns that elevate their own accuracy at the expense of lesser digraphs. They are easily recognized when listed from scientific word counts. Their dominance varies not only with actual use in copy, but also with the resistance met in their typing, as reflected in the student's tension. Interference from a more intense sequence thus mirrors the copy or the keyboard or the student's tension. The result is a transitory blocking or delay, which lasts less than two seconds. Sometimes the typist is aware of this error, and sometimes not.

Literally, numerous errors can be squeezed out if the student can develop an orderly, closer overlapping of his strokes on common words. This is won by typing common sequences in sentences at regular rates. Such rising rates often are happily followed from machine dictation. During such interesting practice at regular rates the delays between strokes grow slight and regular. On each common word the strokes grow closer and more compact, or correct.

Use of these rhythmic rates from which hesitations and errors disappear is handicapped by the "universal" keyboard. Most of the powerful, high-frequency digraphs are absent from its home bank of keys, hence crowded into less-effective arrangement, up or down. Under repeated interference from these unbalanced hand loads and digraph reaches, stretches, hurdles, a rhythmic rate weakens as the typing pace sinks, rises, sinks. Such unduly wide irregularities assault the rhythm throughout a fourth of most typewriting. By contrast, the "simplified" keyboard is designed to kill this wasteful interference and so to protect regular, rhythmic rates. This, in turn, helps protect the student typist against sequence errors. Inevitably, the "universal" keyboard remains an ever-present yet baffling factor in all attempts either to cope with typing errors or to render common words automatic.

Most of the errors, of course, are from common words. The proportion of errors on most common words may actually rise as typing outputs rise. In advanced classes using the old keyboard, increases in accuracy tend to be slight. The 300 words most often mistyped on this keyboard are presented as a list of "typewriting demons," classified both for excessive error and use. The improvement of such errors, however, will be most effective when practiced in a line or sentence setting. The value of learning complete patterns and of measuring line-production outputs is not fully realized. Piecemeal drill on a single word should be justified before it is tolerated. Such a drill may work by detaching as well as attaching a motion, whether correct or false. Thus the monotonous repetition of a single error as misspelled may disrupt the error. Like repetition may similarly disrupt correct typing. Word drills are more often useful either for the slower learner or for completing a special attack on a common word. With difficult typing patterns, initial delay may be employed to complete the attack on a word by first thinking of the entire motion pattern, typing firmly and swiftly, then relaxing. Word drills are sometimes justified as warming-up exercises to stretch and relax muscles of the ring and little fingers. Yet, in general, systematic straight-copy drills, already built on actual studies of errors, are able to reinforce the correct *order* in common words. What counts is the *stimulation* from the student's own tension while following the complete patterns of practical sentence copy.

Most typing errors are thus distinct from several minor varieties of error. First, a beginner's early, fumbling errors are only the excessive action typical of all first starts. This is often intensified by arbitrary neglect of the eyes as a guide for the earliest key-finding motions. Second, copy-reading errors result in reswitching of words. The eye motions of a usual typist are seldom more than one or two words ahead. Insertions or omissions of words then follow personal influences quite unrelated to the run of the typing. Third, faulty technique in nonletter, machine manipulations may contribute a fifth of all typing errors.

Were it not for the obscure handicaps of the "universal" keyboard and of piecemeal drills, pooled errors of many student typists would be evenly distributed by chance as slips due to many sorts of poor technique. It is true that emphasis in student proofreading of typescript is laid on listing errors regularly missed and an accompanying search for the likely interference. Yet to offset their error counts, students should build a careful *technique check list* against which to check each week whether or not essential points required for ballistic stroking and rhythm, machine manipulation, balanced posture, and relaxation are present or absent.

A compilation of student typing errors made on the "simplified" keyboard is convincing evidence that the following are conducive to excessive false stroking or errors: (1) words and letter sequences which must be typed by one hand or by one finger, (2) unbalanced hand and finger loads, and (3) finger reaches and hurdles which are inefficient and awkward from an engineer's viewpoint. When the typewriter keyboard is made scientifically simpler, student errors decrease markedly, as was demonstrated by the Davis comparison of the incidence of errors on the "universal" and the "simplified" keyboard in the Carnegie Foundation study of typewriting at the University of Washington.

CHAPTER XIV

DISCOVERIES ABOUT FATIGUE

* * *

READING SUGGESTIONS

To the Student Typist: Fatigue belongs in your study of errors. Find how fatigue interferes with a steady balance in your body, pages 400 and 401. Find also the meaning of energy cost, feeling cost, individual tolerance, pages 401 to 403. Learn to make fatigue studies of your posture, also of the layout of typing equipment and supplies, pages 403 to 413; of rest periods, pages 413 to 417; and of widely distributed, short practice, pages 418 to 422.

To the Psychology Student: Fatigue study is a baffling yet important topic in applied psychology. Notice the need to review recent work in physiology, pages 400 and 401, and the preference for the more definite terms, *energy cost* and *feeling cost*, pages 401 to 403. Notice again how all aspects of the situation are changed to develop a gradient along which the practice flows, pages 404 to 408. Fatigue study is briefly applied to the senses of hearing and vision, pages 408 to 410. Study of the reaction system is next completed by a detailed analysis of supporting postures, pages 410 to 413. Your interest in fatigue control reaches a high point in the allowances for slight delays during performance, pages 413 to 422. Notice Bills's experiment showing transfer of fatigue through identical letters, page 414, and the automatic barrier against excessive repetition set up by the nervous system, as in the Bills and Telford experiments, pages 414 and 415. Relate such normal blocking to the greater, irregular blocking in errors. Review also Shepard's fatigue study, pages 415 to 417. The accepted principle of widely distributed, short periods for learning is applied to offset fatigue and improve conditioning, pages 415 and 416, in the further light of daily and periodic emotional fluctuations, pages 418 to 420. Try to apply the final review to any motor performance, pages 420 to 422.

To the Typing Instructor: This chapter completes the treatment of errors, as outlined above for student typists. Of special interest are the limiting of finger gymnastics to third and fourth fingers, page 404; time study of "get ready" and "cleanup," pages 404 to 408; and your control of the layout for all surroundings in the classroom, pages 408 to 420.

* * *

INTERFERENCE RATHER THAN FATIGUE

You recall the five girls seated much as five typists are seated in the test room of the Hawthorne plant.[1] You recall that for two years their output of assembled telephone relays has been rising. Their success demonstrates that fatigue is not the major cause when work slumps and mistakes pile up.

1. *Interference with steady body states.* In the light of such experiments, former notions of fatigue disappear. In the human body Cannon[2] observes an extraordinary self-regulation which, under conditions more widely different than in your typing class, maintains a nearly uniform body state, whether in body temperatures, blood pressure, the sugar reserve, or numerous other aspects. Thus a seasoned marathon runner can achieve a "steady state" and show little chemical change in his blood stream. It is the athlete who cannot continue and drops from the race in whom the increase of lactic acid, less alkali reserve, and "oxygen debt" are found. In fact, this chemical picture of fatigue due to "oxygen debt" is infrequent in your typewriting and would be only one instance of unbalance. Instead of blindly crying "fatigue," you need to be alert, says Mayo,[3] to many kinds of *interference.* In your typing class there may be more varieties of unbalance than there are students. According to Henderson, neither you nor any individual can continue work unless you can simultaneously work and maintain yourself in a condition of bodily balance. Any interference with this working balance is quickly noticed in the slump and the piling of mistakes and is loosely dubbed "fatigue."

2. *Illustrations of interference.* To help you break away from the picture of fatigue "poisons," as overdrawn in some childish school physiology text, recall other undue interference with your bodily balance. Emotional upsets in the home are a sufficiently disastrous example of interference that may be mistaken for "fatigue."

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[1] See p. 35.

[2] Cannon, W. B., *The Wisdom of the Body* (W. W. Norton and Company, 1932).

[3] Mayo, Elton, "Changing Methods in Industry," *Personnel Journal* (1930), Vol. VIII, pp. 326–332.

One of the operators on the telephone relay assembly has slumped in output for several days. This girl has seemed quite depressed. Her emotional balance, in other words, her bodily balance, has been lowered. What is her story? Her "boy friend" is of a different nationality. For months her mother has worried over this "foreigner." Finally her mother has stamped her foot and commanded that she find another "boy friend" of her own nationality. When the mother, fortunately, has relented, this operator's buoyance and output has again risen to normal.

In this Hawthorne plant is another experimental group of five girls, who split mica into sheets about $\frac{1}{1000}$ inch in thinness. These girls have stepped up their output 20% with no increased pay incentives. For thirty-five weeks, however, one girl of 18 years has remained slow and erratic. What interference is reflected in this lowest and most erratic output? What is her story? This girl has lived at home with a hard and nagging mother, who has forced her to turn over every cent and has let her spend almost nothing on herself. At the very limit of her endurance, this girl at last has decided to leave home and live with a friend in a small apartment. Immediately her output of work has steadied, even as her own emotional balance has steadied. Four days later she has actually moved to the little apartment. In the following weeks her output has risen to more than 125% efficiency. Released from the tension of this uncalled-for home interference, this operator makes the highest gain in her group.

Do these practical illustrations of interference with a working bodily balance give you insight into the many-sided causes behind slumps in your typing scores, piling up of errors, and a tired feeling? Besides these upsets at home, do you realize how many other kinds of interference can disturb your working bodily balance? Have you caught this problem-solving approach to "fatigue"?

YOUR INDIVIDUAL TOLERANCE

1. *Energy cost and feeling cost of typewriting.* The fact that your typewriting instructor is alertly watching for signs of

interference should launch you on fatigue study. Serious indices of "fatigue" are of various sorts. The energy you are expending in the typing may become excessive, so that a considerable rest period for your recovery is required. An increasing swarm of errors spoils your work, and your speed is markedly slowed. A tired feeling accompanies this loss in typing efficiency.

The energy that you expend in typewriting is derived from oxidation of foodstuffs within the body.[4] In your breathing, a certain amount of oxygen is withdrawn from the air and a certain amount of carbon dioxide is thrown off. A minimum amount of oxygen is essential to maintain the body. This minimum amount is known as your basic metabolic rate. Beyond this point, the oxidation is in a fixed proportion to the amount of your typing work. It is measured in the laboratory by the amount of oxygen consumed or of carbon dioxide given off while you typewrite. *Energy cost* is here a more precise term than *fatigue.* The latter word is too often misleading. The energy cost of typewriting has been measured.[5–6] Obviously, this cost will vary a great deal among student typists and with surrounding conditions. Your weight, the surface area of your body, undernutrition, previous muscular training, emotional upsets, even daily temperature and weather fluctuations, or surrounding details such as the height of your typewriter table are a few among the many complications of energy cost. Do you ever try to guess what a comparison of the energy cost of your own typewriting with that of your classmates might show?

Parallel with *energy cost* Bingham[7] suggests the term *feeling cost* as the price you pay in discomfort, weariness, and distress from long-continued typing. Hour by hour such feelings rise or fall or are revived. These unpleasant feelings of tiredness need not mean that you can no longer typewrite with your usual accuracy and speed. Mostly the tired feeling bulks large; the actual efficiency loss in the typing is slight. Often boredom rules long before your muscles tire. Even if your body has assumed a poor posture for typing as part of your boredom, the feeling cost is out of all proportion to the energy cost. Interest has disappeared, you feel bored, and you also feel "fatigue." In short, what appears as "fatigue" is here loss of interest. This is sometimes called *unrest.* You are merely registering the feeling cost.

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[4] See Page, R. M., "Measuring Human Energy Cost in Industry: A General Guide to the Literature," *Genetic Psychology Monographs* (Clark University, 1932), Vol. XI, No. 5–6.

[5] Carpenter, T. M. and Benedict, F. G., "The Metabolism of a Man during the Work of Typewriting," *Journal of Biological Chemistry* (1909), Vol. VI, pp. 271–275.

[6] Ilzhofer, H., "Über den Energie Verbrauch beim Maschinenschreiben," *Archiv für Hygiene* (1925), Vol. VC, pp. 245–262.

[7] Bingham, W. F., "Achievements of Industrial Psychology," *Mental Hygiene* (1930), Vol. XIV, pp. 369–383.

The first problem concerning "fatigue" which you should solve is this: literally, how much continuous typing can you stand despite the energy cost and the feeling cost? What is your *tolerance?*

2. *Individual typing spurts.* Notice also, as Bingham[8] put it, the "amazing power of the human being to *spurt,* to nerve himself to special effort, to pull himself together and perform his task with precision and speed in spite of weariness or exhaustion." Have you nerved yourself in the same way to conquer some distressing speed test? Do such recoveries of a "steady state" in the face of admitted fatigue further reveal to you how complicated fatigue study is?

COMMON FORMS OF TYPING INTERFERENCE

1. *Variables of motions.* Fatigue is one of the variables in motions, but what do you consider the chief causes of fatigue itself? Doubtless the awkward, clumsy motions into which the beginning typist pours so much wasted effort already strike you as a prime factor in fatigue. The irregular nervous tension under which this beginner operates upsets his working balance to such an extent that fatigue is hastened. A temporary stiffness or even soreness of various muscles, such as those in the upper arms or neck, may be felt. By contrast, you are learning how to relax. You are learning to substitute a loose, *ballistic* movement, launched

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[8] *Ibid.*

from a finely balanced bodily posture. The studies of Freeman[9] already recounted have warned you that higher performances, such as typewriting, demand a certain amount of sustaining muscular tension, but an excess of tension will disorganize the closely timed order within each typing cycle, so that you will feel fatigue. If your control is still limited, then you, too, are soon exhausted by copy which the trained typist handles with ease. Or perhaps the copy is too monotonous, particularly if you must revert to isolated word and nonsense drills and similar dull copy. Or perhaps the class pace is too fast or too slow for your optimal speed. More efficient motions and nicely placed rests and relaxation are prime preventives of fatigue.

2. *Fatigue in fourth and ring fingers.* As you overview your fingers in a study of their fatigue and partial relaxation, do you discover a striking fact? Which finger is tiring first and which seldom tires? Do you watch, for instance, for a weaker typed imprint upon the paper? Clear-cut curves are drawn by Klockenberg[10] to show that your little, or fourth, finger tires quickly. The next finger to tire is your third. Accordingly, you may want to use "warming-up" exercises, such as finger gymnastics or drills on words made up of carefully chosen digraphs, to relax these two fingers on each hand by stretching. On the other hand, first and second fingers, for practical purposes under reasonable loads, can continue indefinitely.

3. *Variables of surroundings; flow of work.* Fatigue study is something you can promptly appreciate, since its immediate result is greater ease for yourself. In fact, both fatigue and errors are the unfortunate opposite of successful motion study.[11] Have you already applied fatigue study to the layout of your typing equipment and essential supplies, to the flow of assigned work through your typewriter? Merely by way of illustration, study to prevent

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[9] Freeman, G. L., "Mental Activity and the Muscular Process," *Psychological Review* (1931), Vol. XXXVIII, pp. 428–447.

[10] Klockenberg, E. A., *Rationalisierung der Schreibmaschine und ihrer Bedienung* (Julius Springer, 1926), pp. 19–49.

[11] See Gilbreth, F. B. and Gilbreth, L. M., *Fatigue Study* (The Macmillan Company, Revised, 1919).

needless fatigue in handling paper. The flow of work in your typing class has already brought paper supplies to your cleared table and copy to your copyholder. Is your machine prepared to help along this easy handling of paper? There is a movable paper guide on the left of its paper table. Is this guide placed by the scale so that paper enters your machine in just the evenly centered position desired? Are your margin stops already set to close the ends of each typed line? Just outside these margin stops have you carefully loosened and set the movable paper clamps to keep the paper snug and firm? Now that you have set the machine, is its paper supply piled within your easiest reach? After you try this place or that place for paper, in the end you probably choose a spot a little to the left of the machine and close to the table's edge, within easy reach of your left hand. Try arranging the paper so that the left edge of each sheet is an inch to the left of its under sheet. Doesn't this help you quickly to grasp separate sheets? For inserting two sheets together, try this arrangement in pairs. If you want to use several sheets and carbons together, here is your chance for clever planning. In short, wasted motions, no matter how minute, contribute their bit to the energy cost and to the more noticeable feeling cost.

Your typing class is like a business office — itself a machine through which work flows. Office management engineers[12] advise you that this work flows in definite directions over definite distances. Of course, its direction should be forward,[13] not backwards or sideways. This typing work also has volume. This volume should, of course, be steady and equal — not often interrupted, nor light today and heavy tomorrow. The pressure of its flow is the rate of typing output, such as net words per minute or accurate lines typed per hour.

By sketching a simple layout of your classroom, you can help plan the practice until it flows steadily and rapidly forward without wasted motion or wasted time for any student typist present. Draw such a simple sketch of your typing workroom, with its fixed and movable furniture, the typewriters and also the teacher's typewriter, the shelves of paper and other supplies, and the files all down on your sketch. Once you have outlined this layout of the classroom, mark down heavy arrows to show the flow of typing jobs to and from each student desk. Now at last you can visualize the flow of work in your class. You can see if typing jobs move forward from the teacher and the supply shelves in straight lines. Are all aisles and tables nicely spaced to help both the lighting and these deliveries? Is there, for example, a class housekeeping committee which keeps the flow of work through your class steady and equal? Do paper and supplies come to you in the order in which you will use them? Can you receive a week's supply in no more time than an hour's supply?

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[12] Leffingwell, W. H., "Typewriting and Allied Operations," and "Flow of Work," *A Textbook of Office Management* (McGraw-Hill Book Company, 1932), pp. 275–285; 347–354; 367–374.

[13] Benge, E. J., *Cutting Clerical Costs* (McGraw-Hill Book Company, 1932), pp. 39, 53, 158, 170–173.

More important still, have you placed all papers and added supplies at your table in order of use, with the most used nearest and the least used farthest from you? Is the surface of your typing table just the right size for your work? If you have a desk, is there a card list of all materials in the drawers and their definite places? Have you also definite places for unfinished work? And where does finished work go?[14] Estimate all the inches your hands must travel over your typing table, as well as the total feet to be traveled to keep you and the rest of the class supplied and cleared away each day.

For several periods jot down a brief record of time spent (1) waiting idly for work, (2) bringing work to or from your table, and (3) actually typing. Through this distance-time study plan a new routine that makes ready materials needed (M), reports the time (T) properly spent in waiting, traveling, and actually typing, and holds down the energy cost (E) — all by means of a more effective spatial pattern (S), or layout of the steps, distances, and stops through which the class work flows.[15] Your distance-time chart thus describes each step in the period's routine — the feet of distance traveled by student monitors; any duplication or back-tracking;

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[14] See Leffingwell, *op. cit.*

[15] See Benge, *op. cit.*, pp. 111–112, 122–123.

and the time spent waiting, in contrast to actual typing, at each student desk. You can follow your typing job from the time it is first assigned to its finish, with heavy lines of arrows, on this layout plan. You know the exact time and place for all *necessary* motions to be made in this period.

The way such a layout is applied to prevent needless fatigue is neatly illustrated if you use a dictating or a transcribing machine. You will then be surprised whenever you start to study your own transcribing. What surprises you will be the size of your *get-ready* and *cleanup* time. Even when you feel at home with machine dictation, time study will clearly show excessive make ready and cleanup.[16] As a rule a good typist will write an entire line faster than he can get ready to start a letter or clean up after finishing. The time of these before-and-after motions, in fact, usually equals from 10% to 50% of all the actual typing. Even trained typists writing at 50 words a minute from this machine dictation often spend 20% of typing time in their get ready and cleanup. Using three or four carbons may double this time. You may be wasting much more. Merely preparing to typewrite eats up usually about one half to three fourths of this added time. Yet slow typists who can least afford it seem still slower in their cleanup. It also seems to be a curious fact that letters and shorter typing jobs of less than 100 lines take more get-ready and cleanup time than do manuscripts and longer jobs of several hundred lines![17]

Any fatigue study of typing dictated by machine naturally includes the number of lines and the time of your typescript. If you are not counting by a standard 6-inch line, be sure to note down whatever line length you do use. Time your get ready and your cleanup in order to compare each with the time you take to type a 6-inch line.

Try keeping a time-study sheet as arranged by Mitchell.[18] In a first column, number your letters. In a second column, enter the time taken to grasp paper, insert a carbon, place these in the machine, adjust the platen to the first line of typing, place the needle in position on its cylinder, adjust your headphones. In a third column enter the typing times, according to lines typed. In a fourth column set down the time taken to remove paper from the typewriter, shake out any carbon, place your typescript with finished work, and check complete on the card strip. Your record then starts like this:

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[16] Mitchell, John, "Measuring Office Output," *Handbook of Business Administration*, W. J. Donald, Editor (McGraw-Hill Book Company, 1931), pp. 905–906, 912.

[17] *Ibid.*

[18] *Ibid.*

	TIME			
Letter	" Get-ready "	Typing	" Cleanup "	Total lines

Nothing is a greater aid in successful fatigue study and prevention than timed routine and records, except of course your actual practice of better motions.

4. *Noise.* When you enter the typing class, you should enter a new world where for once all conditions are set to make the best work possible. Whatever distracts too much is a prompt problem for any student committee that "keeps house" for your typing class. Such housekeeping is bound up with practical hygiene. Does someone regularly make a reading to see that the room is not too hot or the air too dry? A room too hot means less typing. Yet to have air in motion and 50% moist means even more than to hold the room at 68 degrees. Does someone also keep track of excess noise? This is not hard, since a noisy room is very evident.

Since you do your best typing when you have enough tension or tone in your muscles, a reasonable amount of fairly uniform noise may help. The fact that noise increases your pressure on the keys has long ago been demonstrated. Listening to the typing is always a good checkup of the kind of work in progress. Just as light is measured by foot-candles, so noise is measured on an audiometer by units from 0, inaudible, to 100, so intense that the eardrums tingle. Laird[19–20] tells you that 40 units are allow-

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[19] Laird, D. A., "Noise Lowers Efficiency," *Scientific American* (1928), Vol. CXXXIX, pp. 508–510.

[20] Laird, D. A., "Measurement of the Effects of Noise on Working Efficiency," *Journal of Industrial Hygiene* (1927), Vol. IX, p. 431.

able, but that 50 is a critical point. His suggestion is that noise above 50 units naturally starts avoiding movements in any typist. Below this point noise loses this effect. In a study of typists at Colgate University,[21] merely absorbing 15% of noise with wall panels has increased typing speed 5%. In short, with noise cut below 50 units, these typists spent about one fourth less energy for faster typing.

If you try to listen to copy dictated against other noises, you have a very good sample of the strain that noise can add to typing. As the noise of each key stroke slowly dies away, you hear continuously from each machine not one but a dozen blended sounds. To listen to a high, harsh voice is also tiring. A management engineer[22] points not only to scraping of chairs, rattling of papers, occasional talking, clicking of keys, pounding of returned carriages, but also to noise outside the classroom. Since the senses gradually adapt to fairly uniform noise, for the most part you find and plan against only obvious distractions. Partly enclose or put felt or cork pads under the worst machines. Since sound waves rebound from hard surfaces, an expert[23] would advise hangings and absorbing panels like Celotex, and particularly a ceiling that helps absorb sounds and cork, rubber, or linoleum on the floor. Newer window ventilators are an aid against outside noise.[24]

5. *Lighting.* If slow or confused reading is so common a fault with the slow typist, whatever distracts from reading copy can hardly be let alone. Eye defects are so common that a test of vision is the first step. Suppose such vision is corrected. Suppose your head is steady and erect and your body is bending slightly forward to bring the eyes nearer to copy — is the copyholder nicely placed to prevent fatigue of these eye muscles, even of the neck muscles? Perhaps you have a copygraph above the typewriter that holds copy directly in front, with an added guide and lever which mark each line as you type. Perhaps a copyholder is close to the machine's side. If the distance is right from your eyes to

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[21] *Ibid.* [22] Leffingwell, *op. cit.*, p. 182. [23] Benge, *op. cit.*, pp. 79–83.

[24] Laird, D. A., "Noise Lowers Efficiency," *Scientific American* (1928), Vol. CXXXIX, pp. 508–510; also (1929), Vol. CXL, p. 52.

the middle of your copy, however, it is more to the top lines and less to the bottom lines. Possibly you can curve your holder to prevent such uneven distances. When even the best copyholders are somewhat imperfect, the strain on your eyes if none is used costs more and more in energy and feelings.

Poor light goes with tired eyes, slow typing, and mistakes. Tiring eyes are so common while typing that you cannot afford to neglect lighting. From your seat check all points from which light is coming. Where is the most light? It ought to be on the copy. No light stronger than that received from copy should enter your eyes. Bright lights and colors elsewhere, whether on walls or girls' dresses, start tiring changes in the eyes. On the other hand, lightly colored surfaces reflect the light in ways about equal. Even the top of your typing table or desk is preferably of dark linoleum to absorb light without glare. Light rays need to spread evenly over your copy with no glare. Are there dark shades to cut glaring sunlight? Do you have natural light from wide, high windows falling across your shoulder? Is a window less than a dozen feet away? If you like to play with numbers,[25] square the number of feet your copy lies from this window and find

$$\frac{1}{\text{answer}}.$$

This estimates your loss of light with distance. If the chairs are movable, further eyestrain is often avoided by Bennett's[26] "quadrant plan" of seating in arcs that straighten by the windows and turning the individual chairs to avoid strong light. If you must type by electric light, to be on the safe side your teacher should know whether a service engineer from the electric-light company thinks you get enough light. Such lighting ought to be more or less indirect.[27] In short, have you "tuned up" all your surrounding equipment? Think of forceful variables in equipment rather than of inert glass, paper, wood, and metal.

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[25] See Benge, *op. cit.*, p. 71.

[26] Bennett, H. E., "Seating Arrangements in the Classroom," *American School Board Journal* (1926), Vol. LXXIII, pp. 45–46 (Figure 10).

[27] See Leffingwell, *op. cit.*, pp. 140–153.

6. *Sitting posture.* The call for continuous speed despite the handicap of a sitting position makes sitting in particular, as Bennett[28] would doubtless put it, the dominant physical fact in typewriting. Are chair and typewriter table balanced at just the right heights for you? Is your chair, for example, adjustable? Is it a posture chair, specially devised? Your support should fit as comfortably and almost as closely as your clothing. The height of the seat must permit placing the feet squarely on the floor, so that no pressure is felt behind the knees. The front edge of the seat, too, is properly rounded. Typing chairs, accordingly, should be adjustable (and regularly adjusted), or in assorted heights, or at the very least boards should be available for slipping under the feet and under the machine. A second point is the distance of the seat from the machine and the table. If this spacing is too wide, the results are an aggravated stoop and eyestrain in reading copy. The length of your upper arm determines the height of the typing table. The shorter the arm, the higher the table, in order that your elbows may be below the point of typing. From this position an easy, natural slope of forearm, wrist, and hand brings the fingers loosely to the keys. To fit this natural posture, typing tables are somewhat higher today. Oddly enough, some typing students not infrequently are assigned tables that are too low, the reverse of the usual school-seating error.

To help you let go and relax, study your typing postures in the light of relentless fatigue. After all, you are only human. Your posture, for example, is a problem for you to resolve into your easiest position. You do this in the same careful way that you reject the weight of all unnecessary equipment as you prepare yourself for mountain climbing or long camping hikes. Consider very real body weights, such as shoulders, head, arms, as you lean from the hips a little forward toward your typewriter. This slight forward leaning saves eyestrain in reading copy. It becomes very wearisome to support parts of your body continuously. From the seating area of your chair, imagine a vertical upward thrust as an invisible straight-line force. From hips resting firmly on a seat shaped to the body, this line of upward thrust supports the body weights. As far as you can, let the chair bear the brunt. Throw your body weights well forward on the heavy thigh muscles.[29] Balance your upper body, head, arms upon the invisible upward thrust from the chair seat. Turn and watch your typing neighbor while you drop an invisible line from his head to his chair. Criticize to yourself the balance with which he carries head, shoulders, and arms on (or off) this upward thrust of the chair. What is your guess about his probable fatigue?

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[28] Bennett, H. E., "A Study of School Posture and Seating," *Elementary School Journal* (1925), Vol. XXVI, pp. 50–57. For reading, consult Bennett, H. E., *School Posture and Seating* (Ginn and Company, 1929), particularly Chapter XVIII, pp. 246–254, and Chapter XV, pp. 191–194.

Firmness in the back is an essential key to typing posture. A suitable back support is a complicated problem in fitting. Needed shifts in an adjustable back support may move as far as nine inches. Such a rounded back rest, doubly adjustable to fit the individual shape of the back, may be supported by flexible rods curved outward to avoid contact with the body. Without an erect posture closely fitted by the work chair, fatigue is "just around the corner." Either the tension of the back muscles soon is very tiring, or a typical "round-shoulder" position throws the weights on the upper trunk, or the internal organs of the body are heavily compressed. Such interferences involve your breathing and very likely the rhythm of the typing. Perhaps you will understand the importance of these nice distributions of your body weights if you realize the fluctuations in posture of your back. Under the press of continuous typing, Klockenberg[30] reveals by definite measurements how first the upper and later the lower back begins to sag and throw your body further forward. If you do bend your head too far forward, how are you punished? Feel for yourself the painful strain on your neck muscles to support this weight overlong. Consider the weight of the forearms that you must carry. Is the angle between forearm and upper arm a little under 90 degrees, to ease the supporting upper-arm muscles? Pressing this upper arm against the body, Klockenberg[31] finds, decreases the key strokes by 9%. Try to imagine your forearm muscles extending through tendons out to the fingers, to support your stroke. Then you will decide for yourself that a straight line through forearm-wrist-hand is the easiest setup for continuous *ballistic* stroking. This straight line further fits the keyboard incline. Suppose you magnify this slight, natural slant. By raising the typewriter keyboard and so forcing a steep, upward forearm slant, or by sinking the typewriter keyboard and so forcing a deep, downward forearm slant, Klockenberg[32] slows the number of key strokes 20% or more. This nice balancing of your body and all its parts in unison with the typewriter keyboard spells the difference between fatigue and fresh ease in your typewriting.

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[29] Williams, M. S., *Growing Straight* (A. S. Barnes and Co., 1930), pp. 83–95.

[30] *Op. cit.*, pp. 19–49.

[31] *Ibid.*

After you are closely fitted to a seat and typing table, try this simple test: Sit properly erect in your seat and then relax throughout your body. Does a nice balance of your various body weights still permit you to hold the erect sitting posture?

REST PERIODS IN TYPEWRITING

1. *Superiority of frequent, short rests.* If you study for the last time the five girls assembling telephone relays in the test room of the Hawthorne plant[33] notice that one change after another was made to measure its effect on work output. In a series of fifteen such periods, the highest output was reached in the thirteenth. What happened? A fifteen-minute rest and lunch period was given in the morning and a ten-minute rest period in the afternoon. Here is a live and cheering clue to your typing improvement. As one operator remarked when a five-minute rest period was inserted, "My, that's a life-saver!" In like manner, an afternoon pause for "tea" jumped a hitherto "tealess" British typist's output from 1.9 to 2.6 lines a minute![34–35]

The striking superiority of frequent short rests over long but infrequent rests is well known. Suppose you had the patience to try this little experiment: Pause 10 seconds between each two successive movements of a finger. How long could you keep on working this finger without fatigue? The answer is "indefinitely." In this manner, indeed, Shepard[36] estimates your finger could do as much work in one day as it could with occasional long rests in long spells of incessant movement over fourteen days. Or consider similar finger stroking of the alphabet drills, which are so often ineffective. At first, the same nonsense sequence, such as *abc*, is retyped over and over. When Bills and McTeer[37] insert rest periods, however, as *abc* (rest), the total key strokes jump to a 10% increase. You win an even greater gain than that by adding variety to the copy. As the sequence is varied from "two letters the same," as *abd*, to "one letter the same," as *afe*, to "all letters different," as *def*, the key-stroke score registers 4%, 6%, and 8% gains. Thus your gains from avoiding such drills and lessening the transfer of fatigue through identical letters are somewhat surpassed in the effect of rest periods.[38]

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[32] *Ibid.*

[33] Mayo, *op. cit.*

[34] Florence, P. S., *Economics of Fatigue and Unrest* (Henry Holt and Company, 1924), p. 263.

[35] See also Davidson, S. H., "A Study of the Effects of Rest Periods on Learning Curves in Typewriting," Master's Thesis (University of Southern California, 1929).

2. *Automatic barriers against fatigue.* Tie your fatigue study into your trouble shooting for errors. A marked feature of the error, you recall, is the slight blocking in the time of typing your sequence. Of course, this is typical of interference. Again and again you find that an error slightly checks your sequence speed. Naturally, your fatigue study also centers around this blocking that temporarily checks typing work. These momentary checks are typical not only of your errors but also, in slighter fashion, of your total typing performance. In this very slight blocking, you find yourself possessed of an automatic safeguard to prevent you from working continuously.[39] This is your automatic barrier against excessive repetition. There seems to be a similar barrier against immediate repetition. Thus, Telford's[40] students have

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[36] Shepard, G. H., "Effect of Rest Periods on Production," *Personnel Journal* (1928), Vol. VII, pp. 186–202.

[37] Bills, A. G. and McTeer, W., "Transfer of Fatigue," and "Identical Elements," *Journal of Experimental Psychology* (1932), Vol. XV, pp. 23–36.

[38] See also Davidson, S. H., "A Study of the Effects of Rest Periods on Learning Curves in Typewriting," Master's Thesis (University of Southern California, 1929).

[39] Bills, A. G., "Blocking: A New Principle of Mental Fatigue," *American Journal of Psychology* (1931), Vol. XLIII, pp. 230–245.

[40] Telford, C. W., "The Refractory Phase of Voluntary and Associative Responses," *Journal of Experimental Psychology* (1931), Vol. XIV, pp. 1–36.

listened to nonsense syllables at different rates and have written numbers accordingly. Immediately, perhaps for a half second after writing, there appears a slight unreadiness to repeat. During this slight aftermoment, a student's reaction time is slowed. In mental work a slight blocking, perhaps three times a minute, is observed by Bills[41] with fair regularity. These blockings are like slight, cumulative dips in the efficiency wave of your work. Do you not catch yourself feeling momentarily exasperated or amused or otherwise distracted while you typewrite? Underneath such a moment is this blocking. To follow these slight, automatic rests, Bills[42] has tested out many of the usual tasks and found similar blocks in the various types of practice material. Naturally the rate and regularity of this automatic barrier differs with different students. Fast workers have fewer and shorter blocks.[43] More complete improvement from practice lessens the number of blockings and maintains regularity. Fatigue, by contrast, increases these flitting pauses and their irregularity. Errors tend to happen just before such blocks so momentarily enforced. Very likely it would no longer surprise you to find that any errors accompanying high fatigue actually disrupt your typing by excessive blocks.

3. *Continuous effort* versus *standard outputs*. Does unrelieved effort begin to seem absurd? Does insight into these automatic pauses enforced in the self-regulation of your body add to your respect for the companion rest periods regulated by management engineers? Do you find any reason why the Gilbreth fatigue study should apply more to handkerchief-factory operatives than to typists? In such a department Gilbreth[44] found girls pegging away at the folding of fresh-made handkerchiefs. This pioneer in motion studies gave them rest periods that amounted to 21% of their working time. What happened? Three times as many handkerchiefs were folded with more interest and no more fatigue. Do you fully realize just how short such useful periods can be? In a shop job of filing brass metal, for example, Amar[45] used a somewhat smaller proportion of short rest periods to double the

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[41] Bills, A. G., "Blocking: A New Principle of Mental Fatigue," *op. cit.*

[42] *Ibid.*

[43] *Ibid.*

[44] *Ibid.*

[45] Shepard, G. H., *op. cit.*

usual output. His workers filed away intensely for 5 minutes and rested completely for 1 minute; then filed away and rested again. Discovery of whatever changes seem best in these small allowances for delays is an inseparable part of motion study and time study.[46]

It may be your privilege to inspect a large business office or factory under the guidance of a supervisor who has learned to appreciate the value of rest periods. You will notice that the operators do not start feverishly to work at the sight of the supervisor. Employer, supervisor, and employe have learned that greater efficiency results from the wise expenditure of time for recuperation. Proper rest periods are as wise as intense, steady, yet partly relaxed application when working. The supervisor whose appearance is the occasion for a sudden burst of energy on the part of the employes is fortunately becoming less common. The quantity and quality of the finished output is a better measure of efficiency than is continued application.

4. *Estimating your own typing rest periods.* It is true that you have no immediate intentions of typing steadily through an eight-hour day. Happily such strenuous endeavor would not even further your typing improvement. For clearer insight into rest periods, however, the eight-hour day or six-hour day is useful. In doing light-heavy muscular work, what is the least amount of time you would spend in short rest periods (assuming that your work output "begins to slump if you rest less")? By carefully measuring college students working light, chest-weight machines (fortunately with a pay incentive), Shepard[47] finds that the least possible time for short rest periods is 16% of the working time. Moreover, these athletic young men have really rested by lying down and relaxing completely. Even more important, these college students soon are able to select for themselves the work and rest periods best suited to them individually.

Can you by similar fatigue study discover your own best setup of short rest periods in continued typing? If an eight-hour day filled with efficient, light-heavy muscular work demands frequent short rest periods that amount to 16% of the time, you have in this fact a rough guide toward estimating your own rest periods. Time is merely distance, and to break the distance through which your typing practice runs into shorter intervals is simple. Observe, however, that your present typing practice runs only for one class period and that your more intense typing runs in speed tests do not exceed 15 minutes. A clever typing instructor, too, gives you many short rest periods of which you are often quite unaware. Halting the class for proofreading any errors, or a pointed conference, or some student's demonstration of his typing, or the demonstration of a correct motion are good samples. Unless controlled, such informal pauses are even likely to exceed the best proportion of rest time.

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[46] See Merrick, D. V., *Time Studies as a Basis for Rate Setting* (McGraw-Hill Book Company, 1919), p. 336.

[47] *Op. cit.*

When the class routine is lightened by a few informal pauses, you have no trouble in relaxing more completely. Yet how short will you make these rests when independently you try for continuity in your typing? What proportion of your total practice time will they then fill? Your more useful clues are drawn from Shepard's[48] fatigue studies. Late in the day, as you become more tired, it is possible that your own rest periods should total more than 16%. It is possible that you can vary both the size of rest periods and the distance between rest periods, as long as you keep the most practical proportion of total rest.[49] Yet, as you compete with yourself, observe that a greater amount of typing before your rest period very likely means a lesser amount after it, whether separated by 2-minute or 4-minute or other intervals.[50] If you plan very short rests, check your tendency to underestimate time while resting and thus to linger too long. In the same way you tend to underestimate time when typing successfully with no trace of fatigue. Try to improve the balance of your total typing performance by the way you use rest periods.

[48] *Ibid.*

[49] *Ibid.*

[50] Crawley, S. L., "An Experimental Investigation of Recovery from Work," *Archives of Psychology*, No. 85 (Columbia University, 1926).

DISTRIBUTED TYPEWRITING PRACTICE

1. *Eliminating bunched and unproductive practice.* With or without short rests, *bunching* practice into long periods is a sign of inefficiency somewhere. You realize, of course, that typing students who practice two periods instead of one fail in their results to justify the added time so invested.[51–52] In test results the single periods may even be slightly superior to doubled doses of practice.[53] The longer you drill continuously at the typewriter, the more it costs you in energy and feelings. Fatigue arrives. It is not unlikely that results from thirty minutes' intensive typing daily would equal continuous stretches of practice lasting several hours each. Despite continuous daily typing, for example, not a few stenographers remain placidly at the same level won during their last days of typing classwork. Perhaps you do considerable personal writing outside of formal practice. In his own case Butsch[54] could find no more progress after two hours of daily practice — one early in the morning, one in the evening — than after one hour each day. Within 54 one-hour days his speed has risen 8.8 words; within 50 two-hour days, 8.5 words. Between typing tests Butsch would use his machine, off and on, for times running from one to eight extra hours. These added hours have had virtually no effect on his improvement.

You find a like hint from practice in chain assembling.[55] Two groups have assembled chains for ten minutes, then rested ten minutes, during 80 minutes of practice each morning. One group has then practiced 80 minutes each afternoon, also. Since both groups have stayed equally efficient, such doubling of the practice

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[51] Kibby, I. W., "A Study of Typewriting Accomplishments in California Secondary Schools" (California State Department of Education, 1933), pp. 10–17, 24.

[52] Johnson, G. R., "Typing Survey," *Public School Messenger* (St. Louis Board of Education, 1924), Vol. XXII, pp. 1–18.

[53] Young, B. A., "The Relative Efficiency of Single and Double Periods in Typewriting," Monographs in Education, No. 12, *Research Studies in Commercial Education* (University of Iowa, 1932), Vol. V, pp. 136–148.

[54] Butsch, R. L. C., "An Experimental Study of Progress in Typewriting," Master's Thesis (University of Chicago, 1927).

[55] Henshaw, E. M. and Holman, P. G., "A Note on Over-Training," *British Journal of Psychology* (1930), Vol. XX, pp. 333–335.

every afternoon appears as waste of time. Obviously, there is much typing practice that is not productive and might better be relaxed into short rest periods or exchanged for other work. Are you able to interrupt your practice when tired feelings, errors, and accompanying unfortunate conditioning are obviously on the increase?

2. *Your own daily schedule.* As a step in this fatigue study of yours, draw up a simple schedule for your day. This is your substitute for the eight-hour day or six-hour day of business and industry. If for one week you would really note whatever you do for each half hour of an eight-hour day, highly illuminating discoveries would more than repay your temporary inconvenience. In the first place, you would probably be quite disconcerted by the amount of wasteful delays. Very likely you would not want to show this confidential record to others. At least you would be able to check your typing-class period and practice against your own varied daily program. As well as any management engineer, you could see at a glance whether it is really necessary to bunch any typing practice into periods longer than 30 to 45 minutes. The superiority of short, daily practice over the same amount of time bunched in continuous sittings has long been a commonplace of psychlology. Obviously there is a productive part of your practice when you actually improve.

Once you are warmed up and have caught a practical attitude for the day's typing, you should practice just long enough to reap full advantage from this attitude. The more successful "runs" are your high points.[56] At these points usable conditioning signals are attached to successful motions. The case for such short, distributed practice can be formally stated as an important principle of learning. Thus the glance at your own actual daily schedule helps you see further. It helps you fit short practice stretches into widely spaced parts of the day and week. Keep this plan of well-distributed practice reasonably elastic.[57] Otherwise the amount of

[56] See Book, W. F., *Learning to Typewrite* (Gregg Publishing Company, 1925), pp. 297–298.

[57] Goodenough, F. L. and Brian, C. R., "Certain Factors Underlying the Acquisition of Motor Skill by Pre-School Children," *Journal of Experimental Psychology* (1929), Vol. XII, p. 155.

time you use a typewriter throughout a day probably will have no helpful influence on your progress.

3. *Interference outside the typing class.* Watch your typing output for marks of fatigue, notably any slump towards errors. At the same time hold a closer watch on successful advances. Treat typing studies as motion studies. Practice more complete relaxing during informal class pauses, and in your individual practice try out short allowances for rest. Broaden this tryout until you discover how many rests best fit into your definite but well-distributed practice periods. Do slight rests or abrupt changes to other work seem to remove interference from fatigue? Do your pace and rhythm seem to improve? Do errors seem to decrease? If not, seek further for interference.

Perhaps it is a blue Monday, perhaps the practice hangs in hours of the day that are low points of feeling.[58] There are days when your emotional tone will be unusually low or high. Even periodic changes every three to nine weeks are possible.[59] Are such emotional ups and downs separate and quite apart from feeling thrilled with a sudden typing success or finding boredom in typing practice? Try to find the why's that help explain the zigzags in a line of slowly rising scores on your progress chart. Glance again at the intervals between your practice, at the actual events of your entire day outside the classroom. Perhaps tired feelings trace back to outside incidents and persons of the local world in which you live. Perhaps your story of any personal handicap or hunt for hidden interference that upsets your typewriting should extend beyond the classroom.

INTERPRETATIVE SUMMARY

Interference in many forms of which errors are mere indicators is now treated in terms of fatigue prevention. "Fatigue" applies to whatever interferes with the *steady state* essential to a working balance in the typist's body. A continuous steady state is the goal of the trained typist. In the meantime, the trouble shooting for marked interference may extend beyond the classroom. Indeed, a striking illustration is appended of fatigue results from emotional upset in the home life.

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[58] Cason, Hulsey, "General Curves and Conditions of Feeling," *Journal of Applied Psychology* (1931), Vol. XV, pp. 126–148.

[59] Hersey, R. B., "Periodic Emotional Changes in Male Workers," *Personnel Journal* (1929), Vol. VII, pp. 459–464.

Energy cost and *feeling cost* are more definite terms than the misleading word *fatigue*. What is usually termed fatigue is mere loss of interest, boredom, unrest, or the feeling cost of continued typing. Not infrequently this is out of all proportion to the actual energy cost. The latter is measured by the amount of oxygen consumed (or carbon dioxide given off) while typewriting. Despite this energy cost, sudden typing spurts can indicate the unexpected recovery of a steady state.

Fatigue study is applied with remarkable success to reduce energy cost and feeling cost, particularly to improve the flow of typing and to offset the handicap of a sitting posture during fast typing. This handicap is a dominant physical fact in typewriting. Clues to a nicely thought-out balance of all the supporting and pivoting body weights are recounted. This use of balance and relaxation receives emphasis in preventing finger fatigue by carrying the finger weights loosely hinged on the back of the hands. Special care is needed to prevent fatigue in the third and fourth fingers.

The slight blocking in speed of the typing sequence when an error intrudes represents in excessive form the slighter blocking typical in any continuous typewriting. Such slight dips in the efficiency wave of the work, perhaps several times a minute as the young typist feels momentarily exasperated or amused or otherwise distracted, form automatic barriers against excessive repetition. With the faster typists these flitting, regular delays are fewer and shorter. As fatigue increases, however, more and more errors accompany blocking that is noticeably more frequent and irregular.

This self-regulation by the body offers an apt parallel for the companion *rest periods* regulated by fatigue study. During continuous typewriting the output will tend to slump if less than one sixth of the working time is assigned to these short delays. These allowances for rest may take the form of checking typed sheets for an error count or observing demonstrations. Without fatigue study, the student typist fails to discover the best distribution of his rest periods.

In the light of the student's daily schedule, careful planning eliminates bunched, unproductive practice. Instead, successful typing runs and intensive practice are fitted into shorter stretches over widely spaced parts of the day and of the week. Bunching practice in longer stretches, perhaps two or more hours daily, is a sign of inefficiency and fruitless time wastes. The higher standard outputs that follow control by relaxation, rest periods, and distributed work are the consistent modern substitute for continuous effort.

Repeatedly one is forced to the conclusion that during the early period of instruction *the way* a student types is more important than *what* the student types. Typing technique (*form*, in the athlete's use of the word) should deserve primary emphasis. Fluency (rate or speed) should be second. Correct technique and fluency in all phases of typewriting will inevitably be followed by ample and satisfactory output (accuracy). In the office, later, the primary requirement (accuracy) will be assured without undue fatigue by well-established habits of technique and fluency.

PART FIVE

WORKSHOP DISCOVERIES ABOUT TYPING OUTCOMES

CHAPTER XV

DISCOVERIES ABOUT PROGRESS CHARTS

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READING SUGGESTIONS

To the Student Typist: Read this chapter to make "knowledge of your results" definite. Study what your progress chart shows, pages 427 and 449 to 453. This is illustrated by the Towne practice curve and comments in diary form by Towne, also by Swift, pages 428 to 433. To help you interpret your own curve, the form of learning curves is now explained in detail, pages 433 to 438. Notice, for instance, practical upper limits, pages 435 and 436, and how automatic conditioning goes on during wide ups and downs in your curve, pages 438 to 445. Glance briefly to see why you make a separate curve for typing errors, pages 446 to 449. Notice how you compare your scores with the class scores, pages 449 to 453, and how you can use bar charts instead of curves, pages 453 to 457.

To the Psychology Student: This brings you to the learning curve common to all academic subjects. Such a curve crudely represents an increasing area of knowledge or skill, pages 426 to 449. This would be better revealed with refined measurements, such as Thorndike applies to intelligence, page 427. The progress curve, as an incentive, should be accompanied by the student's comments to make clear his attitude. Such comments are illustrated, pages 449 to 459. The form of learning curve and its fluctuations are outlined in detail, pages 433 to 449, also an error curve, page 449. The low correlation between errors and teachers' marks may be of interest, pages 446 and 447. Notice the use of scattergrams to find individual problems in a class, page 452. Bar charts are also described, page 453.

To the Typing Instructor: This chapter stresses the importance, next to the actual typing practice, of a minimum of definite records, which each student interprets by comments in diary form, pages 428 to 433. Of interest are views about fluctuations or plateaus, pages 438 to 445, and the use of class scattergrams to locate individual problem students, page 452. Of interest also is the statistical demonstration that penalties for typing errors decrease correctness of your class measurements and are therefore useful only as student incentives, pages 446 to 449. Instructions for graphing curves and bars, both for test scores and for line-production outputs, are outlined, pages 449 to 457.

KNOWLEDGE OF YOUR RESULTS

There is a theme in the phrase *desired results* which, once stated, has recurred chapter by chapter. It is almost as though invisible guide lines have bound together many pages in the service of a final outcome. Final typing has to be usable in your personal affairs or in the office of business or wherever else applied as a substitute for slower, less legible handwriting. It is each practical consequence that so firmly persists, whether described as a successful climax in your thinking that reduces a typing difficulty or pictured as a finer control that permits tension in relatively few muscle fibers. You see each new success refine and reinforce your stimulation, until usable conditioning signals continue to draw forth successful motions. New patterns of typing complete motion cycles and emerge more compact than before. With the development of these new patterns your success and your confidence rise.

These variations of your theme in Part One and all the workshop discoveries later derived from this rising emphasis are sufficiently convincing. Here at least is one outstanding fact from recent psychology of which you can be positive. *Knowledge of your results*, as already presented, is the outstanding spur to desired changes. What remains is to simplify in definite ways this very knowledge. You should know to the dot that you are a success as a typing student. As typing behavior changes, practice by practice, you want to know positively to what degree of success you have risen. To this end the daily work sheet marks up your day's progress, and weekly test scores fall in place along a curve that charts your exact position. At once you are able to compete in the most heartening of all competitions, which has already been described as competition against your own record.[1]

This growth of your typing skills is mostly definitely pictured as an *area* increasingly filled with varied lines of typewriting. The more tasks of the same typing difficulty that you master in finished typescripts, the wider your typing abilities grow. As the difficulty of your assignments rises, the higher do the skills become.

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[1] See pp. 67–69.

Thorndike[2] aptly refers to the latter as greater *altitude* which, added to *width*, makes a growing area. Think of your entire typing course as both rising in altitude and widening in breadth. In short, visualize in some graphic way this growing area of your typewriting.

Since the exact difficulty of most typewriting assignments is not yet known, as a rule you will chart only the completeness with which you type each test. You will momentarily ignore wide differences in difficulty. You will have to assume that many exercises and tests, taken as a whole, are reasonably uniform, in keeping with your progress. In this way you are able to chart definite figures. These are either the total number of accurate six-inch lines or the number of words (key strokes ÷ 5) typed per minute, less errors. You limit your chart accordingly, in place of picturing the widening area of your typing skills. Timed test by timed test, you simply chart your scores along a gradually rising line. This line of progress may be straight or slightly curved. This line may change so gradually that you must first overlook the scores of many tests before you find the upward slant. Its essential feature is that you are able to watch it rise.

INDIVIDUAL LEARNING CURVES

1. *Towne learning curve.* The line on your progress chart reflects, rather crudely to be sure, the changes in your typewriting. To an extent, as this line behaves so your typing behaves. It lends you new starting points for the study of your own motions. For this reason your own comments on its ups and down are more important than the curve itself. Attend to such a curve in Figure 21, page 429, drawn by Blanche M. Towne,[3] and read this novice typist's own abridged story of her first 100 practices on a portable typewriter. Notice how these comments naturally assume the form of a practical

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[2] Thorndike, E. L., Bregman, E. O., Cobb, M. B., and Woodyard, Ella, *The Measurement of Intelligence* (Teachers College, Columbia University, 1927), pp. 24, 378, 469.

[3] Towne, B. M., "An Individual Curve of Learning: A Study in Typewriting," *Journal of Experimental Psychology* (1922), Vol. V, pp. 79–92.

diary. This personal journal commences on the fifth day, with a popular manual open beside the typewriter:

> At the outset, to locate the desired key, reach with the correct finger, and then strike the key required special attention. The *a*, *s*, and *l* strokes soon needed no attention, while *g*, *b*, and *y* still caused trouble, which I later found lasted until the sixtieth day of practice. One key stroke, *x*, was not automatic even at the very close. Yet before fully half of the keyboard was automatic, certain combinations, as *es* and *tion*, were completely so. The rise in my learning curve on the fifth day was due to repeated practice of a review exercise attended with very few errors. On the next day, new materials caused more errors and a drop in the curve. These errors kept coming in bunches and left a very confused feeling. Likewise, on the tenth day, a sudden rise in the curve was due to the use of old material, resulting in fewer mistakes and in a feeling of exhilaration, especially as I had been detained from practice for a few days. A drop on the next day was caused by new material and the writing of many letters with many mistakes. The use of the shift key kept the curve down for the next few practices. Painstaking work seemed to account for the decided rise on the nineteenth, twentieth, and twenty-first days.
>
> During the next few practices, I found myself confused whenever I tried to watch the copy. Up to this time, I had been looking into space or closing my eyes instead of watching the writing. The movement of the paper and the little letters flying up and down annoyed me. Besides, I found myself stealing glances at the keyboard. This irritated me, and I felt that I was making no gain in the work. I felt that it had become drudgery. The very low score on the twenty-first day seemed to have been accounted for, in part at least, by the frequent use of the shift key for numerals. The next day the score was very little better, however, and the work was very exhausting. The same feeling continued during the nine days that I worked on this lesson. This probably came from the high tension in my muscles.
>
> A feeling of calmness followed. I worked slowly and carefully, reaching a higher score than previously except for the one score on the thirtieth day. Then the beginning of a new lesson brought the score down again. I began to feel some pleasure in the work. The weather grew cooler. The more careful application resulting soon brought the number of errors down to one for a whole practice. However, the slow work reduced the number of key strokes and, in consequence, the curve dropped to a new

low level. A new lesson requiring new parts of the machine kept the score down two more days.

Up to this time the curve had no plateaus at all. But when the curve next rose, it remained at the same level for about twelve days. This period corresponded exactly with the time spent on lessons Ten and Eleven in the typewriting manual. These contained the first whole paragraph and the first whole page to be written without repetition. How great a difficulty this was! I also emphasized speed during this period. [There was not one mention of pleasure during that period and once a great dislike of the copy was expressed.] This period of stress and strain left a feeling of discouragement, which persisted until Lesson Twenty-seven. Each day I had to drive myself to the practice. Even a perfect copy brought no desire to start another lesson.

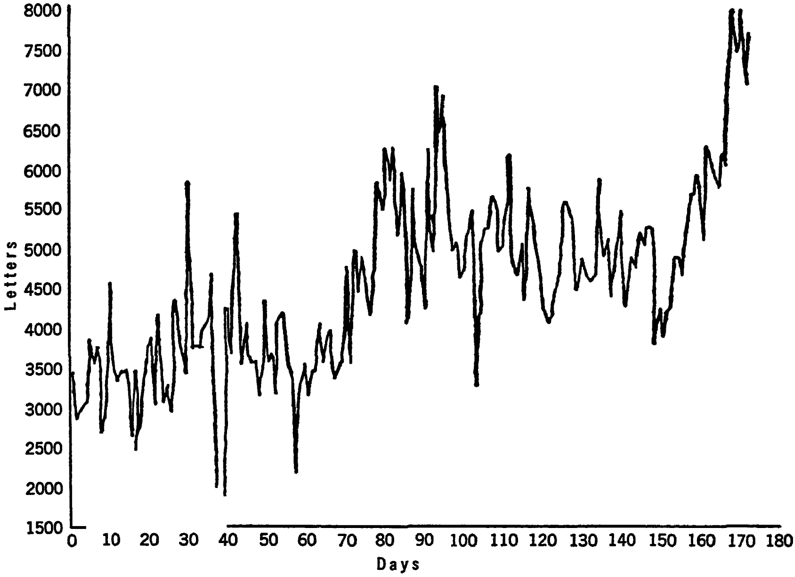

Figure 21. Progress Curve during Practice by Blanche M. Towne[4] upon a Portable Typewriter

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[4] Towne, B. M., "An Individual Curve of Learning: A Study in Typewriting," *Journal of Experimental Psychology* (1922), Vol. V, pp. 79–92.

It was, however, just at this discouraging moment that the score went up very rapidly. The first group of small words had been written automatically about the fortieth day. Letters, syllables, words, and groups of words began dropping into the background. By the end of the sixtieth day, short familiar words, such as *and*, *the*, *we*, caused no trouble at all.

The second plateau from the seventy-seventh day to the ninety-second day maintained a clear and distinct level, although a higher one than had hitherto been reached. Both a decrease in the number of errors and an increase in the number of key strokes typed combined to bring this higher score. The material, while in reality no easier, seemed so. The increases were on short and more interesting copy. [Many allusions to growing confidence and pleasurable feelings now appear.] For the first time I had actually become happy in the work. During the last few practices, the curve again started upward, accompanied by pleasant feelings and self-assurance.

For something over six months, I put my new portable aside except for rare occasions. Then I renewed my practice periods for 76 more days. In this second series a sudden drop was to be expected because I turned to copying essays. This material was much more difficult both as to spelling, punctuation, and thought. I did not divorce the ideas from the copying. Yet strange combinations in foreign or unfamiliar words brought letter strokes once more to the front. The first fifty days were on the same level. I took up the task each day as one of my regular duties. I felt no false elation nor any great depression because of the fact that I was not gaining. It all seemed a part of the day's work. Occasionally I tried to spurt, but the gain was of very little significance.

Then I decided to put emphasis on accuracy. The result was a decrease in the number of errors and also a decrease in the number of words written, which, of course, caused a fall in the curve. In order to offset this fall, I reconsidered my method of reckoning the score. Hitherto I had divided the number of key strokes by the number of errors. As this seemed too great a price to pay for an error, I decided to change my plan to a 5-stroke penalty for each error. At once I found my attitude changed from a certain watchful tenseness toward errors to one which was a little more relaxed and which emphasized speed. This accounted for the following rise. Every day I felt a little more free than on the previous day and therefore could speed up a little more. I also felt that this accounted for the high level that was soon reached. Though not very much higher than the preceding plateau, this level was about proportionate to the relaxation from tension which was felt before.

During the next six days of practice I was back on material of the same difficulty as the exercises in my manual at the close of my earlier practice. The result was what might be expected. The curve rose a little higher than at any other time and held this height. Incidentally, this shows how little real gain had been made during the last seventy days of work.

You have just watched a real learning curve rise, fall, twist, stand still, or otherwise misbehave. You have just read Blanche M. Towne's own account of all that this curve meant to her typing. The high points of what was felt and done, rightly or wrongly, are there. Are you already willing to recognize what an outstanding, even central, role in self-directed practice the progress chart and diary comments can assume?

2. *Swift learning curve.* Do you wish to follow another psychologist, Swift,[5] along a similar path? Here is another diary statement, adapted and abridged from this scientist, who shortly will contribute again to your insight into plateaus:

The first rise of my learning curve in typewriting was more rapid than in shorthand. On the fourteenth day of typing, however, I fell into a long drop due chiefly to harder copy. I had just changed from personal letters to lectures on the history of education. It took seven days before my curve rose again. Pleasure in the work that had colored the first dozen days gave way to ennui. This entire week passed as one of discouragement.

By the twenty-third day, I was still reaching to individual keys as such, but more quickly. My hands and fingers were clearly becoming more flexible and adept. The change then going on, aside from growing flexibility, was in learning to locate keys without waiting to see them, in other words, to find keys by position. The boredom recently so noticeable was disappearing. The feeling of pleasure which colored the beginning of the work returned.

I found myself writing easily on the twenty-fifth day, so easily that I came near relaxing overmuch. Although keyboard locations were not yet automatic, common, short words like *the*, *is*, and *an* seemed to lose their letters and become words. The very next day, moreover, the keys were not struck so readily. My feelings were at once very different. Only with the greatest effort could I keep up my score. With yet another day, however, the work ran easily, the feeling of the last practice was entirely absent. I felt that I could do it and that I was doing it successfully. I was also able to look ahead somewhat, and this helped.

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[5] Swift, E. J., "The Acquisition of Skill in Typewriting," *Psychological Bulletin*, Vol. I (1904), pp. 295–305.

By the twenty-ninth day, stroking by the motion feel was improving. Up to that time the only words that could be said to be responded to as words, instead of as words composed of certain letters, were still *the*, *an*, *of*, and *is*. Only when I kept myself keyed up did I react to these words as words instead of to the letters composing them.

Starting the thirty-second day, I began to doubt whether I was writing any faster. Indeed, I seemed to find the keys with a little more than the usual difficulty, but I "pulled myself together" sooner after finishing a word. I kept nerved up to the work. The result was very exhausting and could not have been continued much longer than an hour. Even in short, common words letters constantly tended to obtrude. Two days later the severe effort to maintain efficiency resulted in a continual struggle to keep my scores from sinking. Repeatedly I put forth great energy, which would immediately droop. Yet during these three days my learning curve had begun a new and almost continuous rise. Still the spurs had to be applied.

By the thirty-sixth day, I was writing more by words than at any previous time. Unquestionably two days later word writing was more frequent. Yet any little difficulty caused me to drop into letter writing, even after I seemed to start on the words as wholes. The keyboard positions were also improving in definiteness. Irregularly, a word or a position became prominent.

On the forty-first day, the writing was clearly increasing. Words were written at once without any awareness of the letters. Yet the very next day, my loss of enthusiasm seemed the only evident cause for a drop in the progress curve. A feeling of monotony grew marked. Even on the following day I felt mentally tired. A great effort to raise the score failed. At the end of the hour, I felt exhausted. Yet the following day everything went easily and again I pushed myself to the utmost. A renewed picture of fatigue appeared the very next day. The work did not go well. Even finding the key positions was harder than usual. Not infrequently I anticipated by striking a letter key one or two places ahead of the right one. Yet, as the fiftieth day arrived, I was writing with an ease not before experienced.

You have read just enough of this story to suggest the ups and downs in Swift's own progress chart. Perhaps you also have noticed occasions where this learner suddenly finds himself doing something of which he has not before been aware. These and other features of practice, correct or incorrect, are set forth in a personal way.

COMPLETE LEARNING CURVES

1. *Compromise between simple and difficult skills.* The more you experiment with a typewriter, the more you will be willing to admit the unexpected ups and downs between different typing skills. Recall in your mind's eye the drawings of separate class curves for the space-bar stroke, the shift-key stroke, and the carriage return.[6] While these represent only three skills, the time for the first is almost nine times as great as the time for the third. Suppose you reconsider the Coover [7] times for experts tapping the digraph *jj* as 100% slow speed. Not only is *jm* 113%, or 13% slower, but *ik* is also 73%, or 27% faster, and *jl* is 69%, or 31% faster. Suppose you consider from the Swift [8] diary the remarkable rapidity with which *an*, *of*, *is*, and *the* fuse early into complete words. Evidently certain typing patterns are far easier and faster than others.

What is happening in your learning curve? For the simpler skills a steep and high learning curve would rise very rapidly. For the difficult skills a gradual, low learning curve would crawl slowly upward. Fortunately your own progress curve is to estimate only the *completeness* of your typing improvement. Your own learning curve is to be a smooth compromise between numerous simple and difficult skills. Isn't this fact beautifully mirrored in Thurstone's [9] sketch (Figure 22, page 434) of such a compromise curve? Notice how slowly the bottom curve for a difficult skill rises. Notice how rapidly the top curve for a simple skill shoots up. In between rises a complete learning curve that melts the directions of all other curves into one general upward rise.

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[6] See pp. 328–330.

[7] Coover, J. E., "A Method of Teaching Typewriting Based upon a Psychological Analysis of Expert Typing," *Proceedings* (National Education Association, 1923), Vol. LXI, pp. 561–567.

[8] *Op. cit.*

[9] Thurstone, L. L., "The Learning Function," *Journal of General Psychology* (1930), Vol. III, pp. 469–491.

2. *Concave-convex curves.* As you admire this smooth learning curve, probably far less erratic than your own will appear, certain features bring you its pattern:

(1) Notice that such a curve starts somewhere above zero. Any new student enters his first class with sufficient ability to hunt and peck a visible keyboard without training. Thurstone[11] estimates this untrained skill is equal to a little less than 7 words a minute.

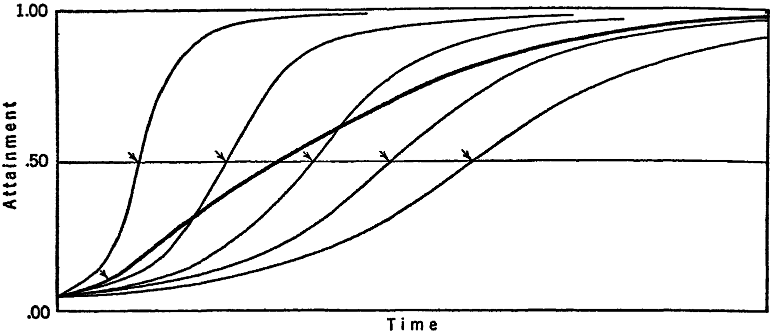

Figure 22. Composite Curve Merging in One-line Rapid Advances for Simple Skills and Slower Advances for More Difficult Skills (From Thurstone[10])

(2) Observe that such a curve is rising quickly at the outset. Why? Because the simpler skills are quickly gained. This is called its *positive acceleration.*

(3) Even in the lower half of this curve, however, you cannot miss the gradual slowing of this improvement. Why? Because more difficult skills resist further progress. This slowing is called its *negative acceleration.*

(4) As typewriting practice goes on and on, what is happening to the curve? You see its increases slowing, becoming more and more sluggish until the curve is barely rising. Why? After all, a typist is only human and is now approaching natural limits. Beyond such limits the ordinary typist feels it scarcely worth the very real effort

[10] From Thurstone, L. L., "The Learning Function." *Journal of General Psychology,* 1930, 3. Pp. 469–491.

[11] Thurstone, L. L., "The Learning Curve Equation," *Psychological Monographs* (1919), Vol. XXVI, No. 114.

necessary to rise. After measuring fifty typewriting students in Pittsburgh, Thurstone[12] seems to locate this ordinary limit on the "universal" keyboard at some 50 net words per minute. Isn't this rather low? Hesitate before you answer this pointed query. Your reply may reflect real distinctions, not only between different teaching or different keyboards or different typing jobs, but also between the ordinary and the superior typist.

3. *Rising limits of skill.* Lift your eyes momentarily to the professional typewriting heights. Certainly it would be amusing to find earlier championship speeds once upon a time set as the final limit for highly energized national rivalries. In today's school competition student scores equal these early championship speeds. A decade after the first champions, Margaret B. Owen tossed out continuous typed sheets at 143 words each minute. Yet writing in a flash for only one minute, this expert also typed 170 words perfect. Eight years after winning among novices, George L. Hossfield likewise reached national honors with 144 words continuously every minute. Ever since, the championship has mostly been tossed, like battledore and shuttlecock, between this careful typist and the flashing Albert Tangora. The one has speeded to 131–144 words, the other to 130–147 words, to win an hour of typing. These are timed records of the international contest with its earlier silver trophy cup and lone judge, J. N. Kimball. Its famous scoring rules, however, do not apply in full to many of these records. Hortense S. Stollnitz, fastest among novices, holds, too, the fastest continuous gross — over 159 words maintained each minute.

Even when you drop your eyes to more lowly levels of an advanced typewriting class, you have ample reassurance from Butsch[13] that limits are still rising. Your mere glance at one learning curve (Figure 24, page 439) pictures a second-year typing student advancing from 54 to 83 net words per minute — although beyond 80 net words, this curve is still rising an added 2 words after every five speed tests. The usual curves of this second-year class are already beyond 60 net words and are still rising. Their slopes, to be sure, are very gradual. The amount of time and effort often required seems almost shocking. Yet 2 net words are usually added after at least seven speed tests. Underneath the erratic fluctuations in these illustrative curves, you can discover an invisible, nearly straight line still slowly rising, even as advanced practice ceases, well past any arbitrary 50 net words per minute. Even Butsch's[14] own private struggles with a typewriter should be graphically pictured. His learning curve rises as a slow, straight line, through 50 daily tests, from 77 to 86 words each minute. These 50 hours of practice have slowly added 8½ words per typing minute. Apparently all these curves cease to rise only when practice is dropped.

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[12] *Ibid.*

[13] Butsch, R. L. C., "An Experimental Study of Progress in Typewriting," Master's Thesis (University of Chicago, 1927).

There are certain physical limitations, however, in the typist's muscles[15] and nervous system, just as there are limitations in the common typewriter keyboard, to speeds much in excess of present records. Today's slow-motion pictures of champions, as you will recall, visualize the handicap to speed in the "universal" keyboard. Films show the absence of an actual home row, the repeated idling of one or the other hand, and the forcing of excessive motions. When usual students use a "simplified" keyboard, for example, their growth in speed remains quite uniform beyond 50 net words per minute. Even at this rate the usual delays marked as plateaus[16] have not yet appeared. Obviously, this rate is ample for most personal typewriting. Lack of a real need or any practical incentive suffices to set comfortable limits for the majority of student typists well below highly skilled operation at 100 words a minute. There is plenty of company when you type far below your possible levels.

4. *Straight-line slopes.* Most of the learning curves which you will see match the speed against the practice time. Otherwise stated, words (or strokes) per minute are plotted against days (or weeks) in time. When Thurstone[17] has noticed a shocking lack of industry shown by some Pittsburgh business students during practice, he has shifted his chart to match the speed against the amounts typed.

[14] Butsch, R. L. C., "An Experimental Study of Progress in Typewriting," Master's Thesis (University of Chicago, 1927).

[15] See p. 208.

[16] See p. 444.

[17] *Op. cit.*

This would be to plot your words per 4 minutes against the number of pages written in the practice. This usual curve appears in Figure 23. In order to secure 51 genuine curves that show this usual convex line, however, it has been necessary to throw aside the scores of 32 typing students. Most of these have seemed too erratic because of irregular attendance or sheer lack of interest. Five have showed the slope of a straight line.

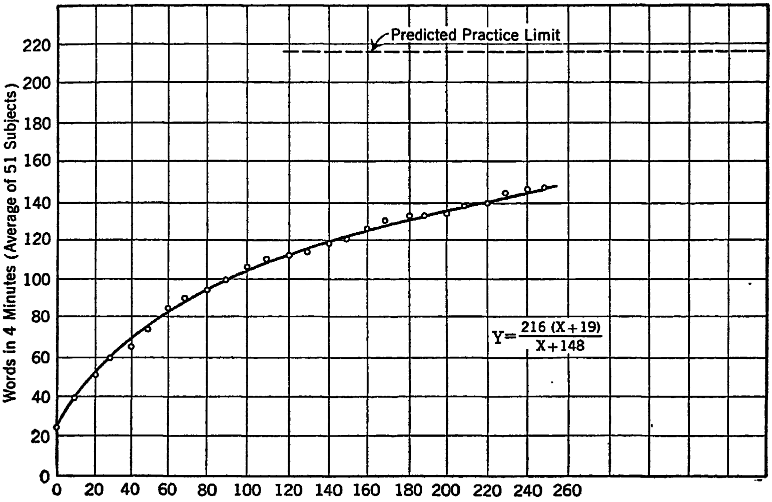

Figure 23. Typing-class Progress Chart, Showing Convex Curve (From Thurstone[18])

After charting class scores for two years, Chapman[19–20] sees the usual typing-class curve as a straight line for a term, or 90 hours of practice, then growing nearly horizontal, that is, level. Other early practice curves,[21] after the first few days, are almost straight lines slanting upward. Even the upper half of the practice curve for the Pittsburgh business class (Figure 23) is practically a straight-line slope. Certainly the second-year curves drawn by Butsch[22] are such straight-line slopes (Figures 24 and 25, pages 439 and 440). Because this second year represents but 40% of the improvement by these students, 60% of improvement has lain in their beginning year. At the outset, no doubt, these curves have risen more steeply up a somewhat curved slope. With this proviso in the background, study the best of the three second-year samples of learning curves (Figure 24). Lay your ruler or other straightedge through the middle of the line's fluctuations up and down, in order to bring out the invisible straight line under cover but gradually slanting upward to 83 words net (note the dotted line inserted). Do not allow so many curious fluctuations to hide the true upward slope of your progress line.

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[18] From Thurstone, L. L., "The Learning Function." *Journal of General Psychology*, 1930, 3. Pp. 469–491.

[19] Chapman, J. C., "The Learning Curve in Typewriting," *Journal of Applied Psychology* (1919), Vol. III, pp. 252–268.

[20] Chapman, J. C. and Hills, M. E., "Positive Acceleration in Improvement in a Complex Function," *Journal of Experimental Psychology* (1916), Vol. I, pp. 294–507.

[21] Hill, L. B., Rejall, A. E., and Thorndike, E. L., "Practice in the Case of Typewriting," *Pedagogical Seminary* (1913), Vol. XX, pp. 516–529.

ERRATIC FLUCTUATIONS AND INDIVIDUAL PLATEAUS

1. *Daily and weekly fluctuations.* Study the fluctuations of another second-year student (Figure 25) in comparison with the chart of the more successful student in Figure 24. Lay your ruler through the midst of these fluctuations (note the dotted line inserted) to bring out a hidden line which gradually slants upward for a complete speed gain of 26 words. Isn't it interesting that this entire gain between the averaged first and last (five) tests is already momentarily achieved in the averaged 25th to 29th tests and almost achieved in the 58th to 62d tests? This is advancing and receding in extreme fashion.

These erratic, quite zigzag fluctuations[23] are natural under present uncertain methods of instruction and under the waning and returning of student interest. Book[24] has nicely stressed the close way student feelings follow these ups and downs. To an extent daily life is like that. Since the more erratic fluctuations are very infrequent in some students' curves, they are hardly essential features

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[22] *Op. cit.*

[23] Bradford, C. G., "An Experiment in Typewriting," *Pedagogical Seminary* (1915), Vol. XXII, pp. 445–468.

[24] Book, W. F., *Learning to Typewrite* (Gregg Publishing Company, 1925), pp. 298–300.

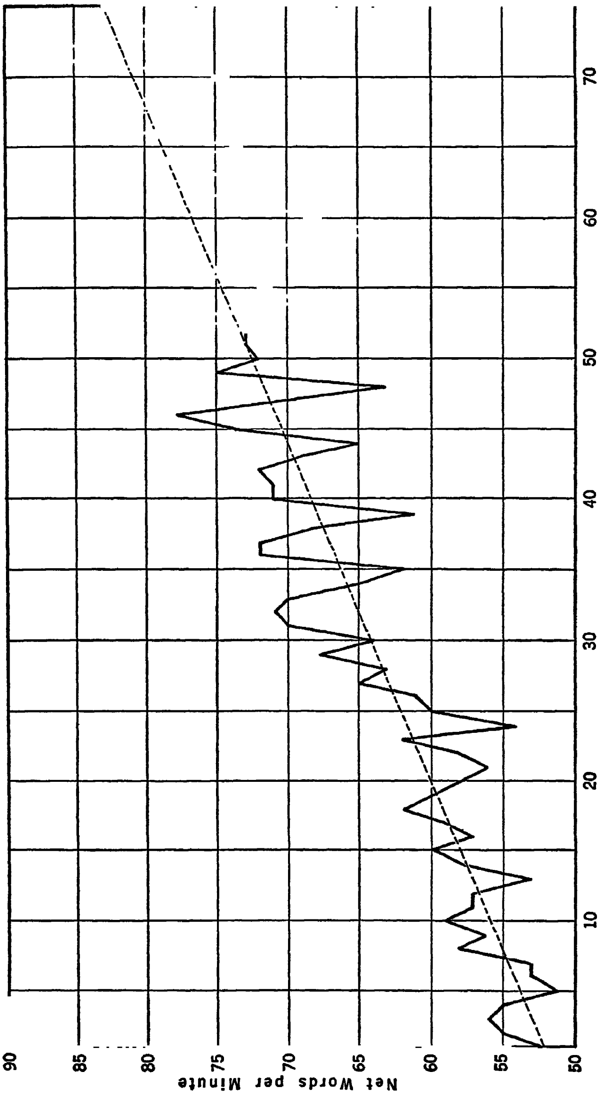

Figure 24. Progress Curve for a Superior Advanced Typing Student (From Butsch[25])

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[25] *Op. cit.*

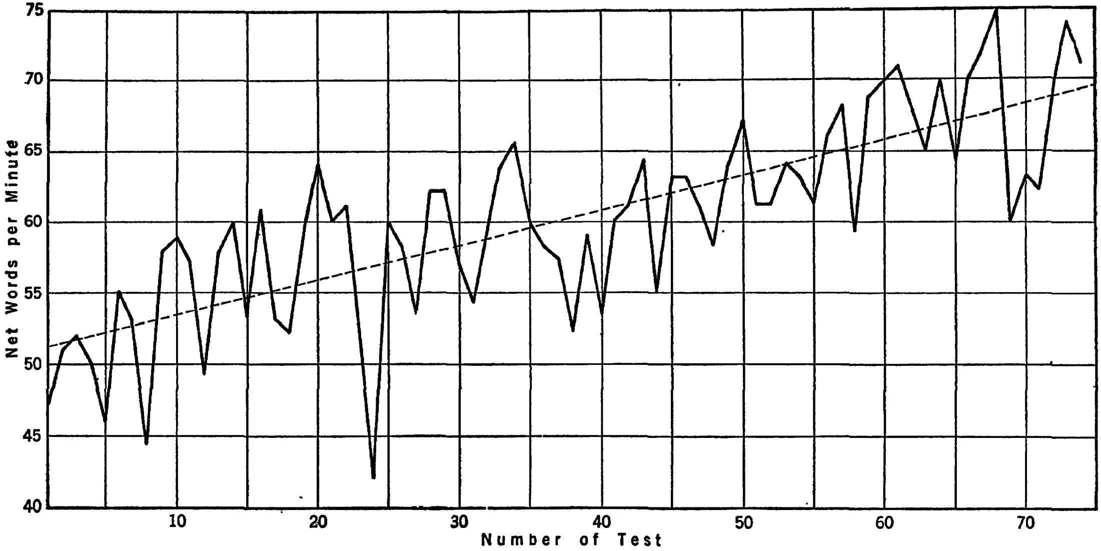

Figure 25. PROGRESS CURVE FOR AN ADVANCED TYPING STUDENT, SHOWING WIDE FLUCTUATIONS (From Butsch [26])

of your typing improvement. Sudden drops are symptoms of underlying interference to be handled by the usual problem-solving attack. Recall the simple reasons given for serious drops in the Towne curve.[27] Whenever errors mount or speed lags, probe for interference somewhere.

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[26] *Op. cit.*

2. *Avoiding plateaus.* For further insight into fluctuations, study the third curve of learning in Figure 26, page 442. Lay your ruler in the midst of the up-and-down fluctuations between the 14th and 41st speed tests. Beneath the mask of erratic fluctuations do you see how, during this entire period, the line runs flat with no real rise? This period of no or little apparent progress could be called a *plateau,* although its interesting features cling to the erratic and excessive fluctuations. This student has improved only 14% during his second year. Yet a comrade, starting with the identical score within the same time and class, has registered a 43% gain. Apparently classmates who begin their second year with identical scores may achieve surprisingly different final outcomes.

Interest in plateaus has waned of recent years, since they are no longer considered essential features of typing improvement.[28] You have read the story of the Towne[29] progress curve, picturing several such flat stretches, becoming longer at higher, difficult practice levels. Such periods of little or no advance are more often buried under excessive daily individual ups and downs. In fact, it is often impossible to know just what or where the plateaus are. Although they drain away much time and energy, this is only tantamount to saying that the struggle with typing difficulties can be a slow, laborious affair. Plateaus in many other student curves[30] are *short and seldom occur in the same places.* Even with young children, plateaus are not to be coddled.[31] Indeed, why not break up every such arrest by thinking through the underlying trouble or by adding new incentives? Here are two possibilities: (1) This halt in

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[27] Towne, B. M., *op. cit.*

[28] McGeoch, J. A., "The Acquisition of Skill," *Psychological Bulletin* (1931), Vol. XXVIII, pp. 414–415.

[29] *Op. cit.*

[30] Chapman, *op. cit.*

[31] Freeland, G. S., "A Year's Study of the Daily Learning of Six Children," *Pedagogical Seminary* (1921), Vol. XXVIII, pp. 97–115.

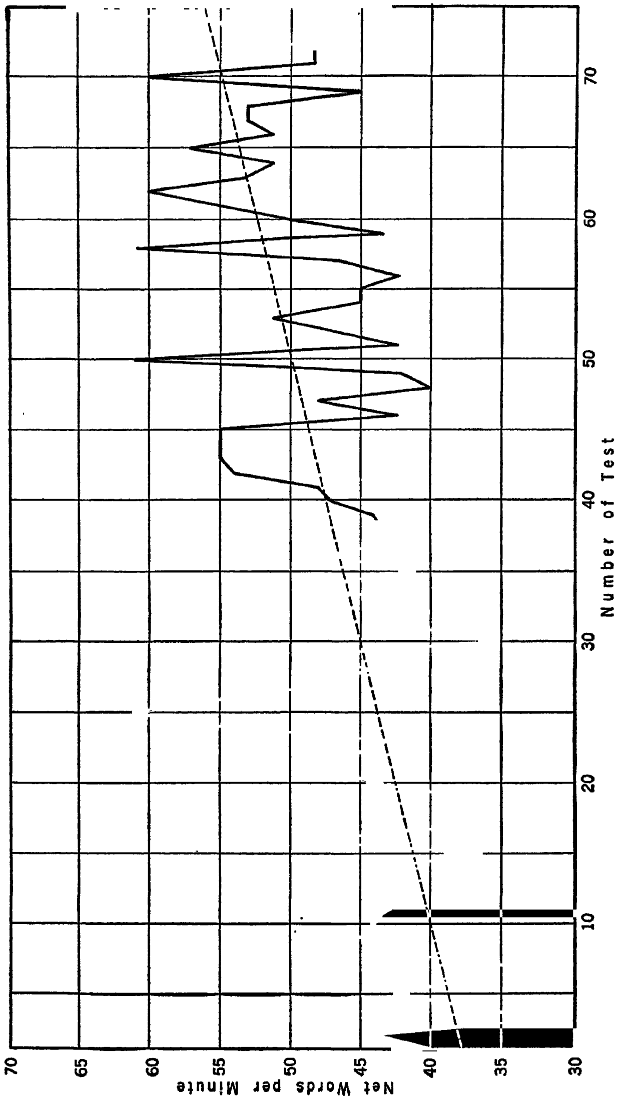

Figure 26. Progress Curve for an Advanced Typing Student, Showing an Excessive Plateau (From Butsch[32])

progress may be only seeming, since automatic conditioning kee right on. (2) This automatic improvement during a plateau m be contrasted, as Swift[33–35] again and again contrasts it, with t sort of arrest known as "breathing places." These "breathing place are fully uncovered by Book,[36–37] who has measured distinct slowed pulse rates during arrested progress as signs of a slum in effort and enthusiasm. During just such slumps efficient m tions readily disappear, since their signals are no longer reinforce Such short arrests may only reflect a drop in your physical conditio The usual, longer plateau, on the other hand, probably represen suspense while you await automatic conditioning of new motion You have to be alert, accordingly, and try new ways. Any ne conditioning depends on this added stimulation from you and yo surroundings. Swift[38] actually sees more intense effort, follow by an evident sigh of relief when the improvement again resume

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[32] *Op. cit.*

The feature of such a plateau, if you experience it, lies in the errat ups and downs that reveal your *confusion* in facing new difficultie When any such plateau does end, its difficulties have been reduce and your skill probably is greater than before. Beyond 30, som times even 20 words a minute, these delays on the "universal" ke board increase. Further gains may be so sluggish and diffic that, as George[39] suggests, much advanced typing has the appea ance of a plateau, due to early stress of isolated letter strokin Student speed soon reaches the slow letter-method limit, and onl with laborious effort could you or others subdue accumulated inte ference from its wasteful early conditioning. The fact that studen using the "simplified" keyboard approach 50 net words per minut

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[33] Swift, E. J., "Review of W. F. Book's *Learning to Typewrite*," in *School an Society* (1926), Vol. XXIII, pp. 372–373.

[34] Swift, E. J., "Learning to Telegraph," *Psychological Bulletin* (1910 Vol. VII, pp. 149–153.

[35] Swift, E. J. and Schuyler, W., "The Learning Process," *Psychological Bullet* (1907), Vol. IV, pp. 309–310.

[36] Book, W. F., "The Psychology of Skill," *Studies in Psychology* (University Montana, 1908), Vol. I, pp. 155–158.

[37] Book, W. F., *Learning to Typewrite* (Gregg Publishing Company, 1925 pp. 276–287.

[38] Swift, E. J., "Learning to Telegraph," *op. cit.*

[39] George, G. C., "Typing Plateaus," *Journal of Business Education* (1932 Vol. VII, pp. 17–18.

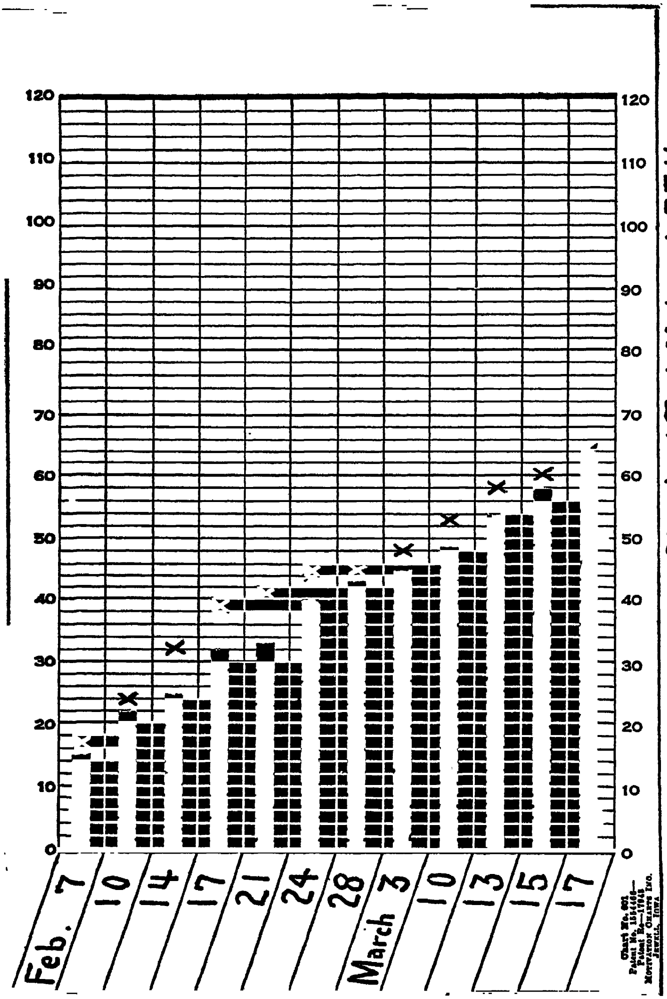

Figure 27. "Motivation" Bars, Illustrating Absence of Early Plateaus ("Simplified" Keyboard)

without this slowing up of progress, as shown in Figure 27, suggests the "universal" keyboard as a major cause of such plateaus.

YOUR TYPING CURVE NOT NECESSARILY TYPICAL

1. *Differences in early typing gains.* Even the start of your learning curve at the very beginning of the typewriting course is not simple. It is apt to vary curiously. If penalized, it is a flat procession of zero scores.

Becoming acquainted with the machine and locating keyboard positions is not yet typewriting. For this reason Chapman's curves do not start until the twentieth practice period and Thurstone delays three weeks before scoring any tests. Probably you recall the latter's estimate[40] that a new student brings with him into the classroom ability equal to some 19 pages of formal typing practice.

Once launched, does every beginner's curve rise more and more rapidly at the start? The short lower part of the curve, with this accelerated start, is often missing or lasts only a few days. Some curves[41] show this acceleration in the first 60 practices; others do not. A change from a rapid to a slower rise sometimes occurs in the neighborhood of 17 words a minute.[42] A rapid advance may later reappear around 21 words a minute.[43] Certainly this first rush is not an essential feature of your typing progress. Today this feature is more often expected in the curves of young children and immature or slow students. If it has appeared in your typewriting, McGeoch[44] hints, this might be due to your method of attack or to the complicated mingling of typing skills. In the latter event, the rapid gains upon simpler typing skills (Figure 22, page 434) are mirrored in your early curve.

2. *A class curve blankets student differences.* In short, *there is no typical curve* that fits all typing students. This point is sharply brought out by comparisons among two-year progress charts.

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[40] Thurstone, *op. cit.* [41] Chapman, *op. cit.* [42] Thurstone, *op. cit.*

[43] Kjerstad, C. L., "The Psychology of Learning: An Experimental Study of the Form and Fluctuations in the Learning Curves of Typewriting," Master's Thesis (University of Chicago, 1916).

[44] McGeoch, J. A., "The Acquisition of Skill," *Psychological Bulletin* (1929), Vol. XXVI, pp. 458–459.

There may or may not be rapid rising gains at the outset or even later. The curves may be convex or concave-convex or sloping straight lines. Here is an illustration: Your curve for repeated practice sentences is not at all like your curve for straight copy.[45] Real changes in practice material alone will shift the form of your curve. Neither wide fluctuations nor plateaus have to be in the picture. Such fluctuations may be weird, wide, and erratic or even inconsequential. When all class scores are pooled, however, the effect is to throw a common blanket over the astonishing differences between you and other students and your separate paths to successful typewriting. The value of your own learning curve is chiefly as an incentive to you who build it. It is so valued as an incentive because it portrays vividly your personal results, in contrast with massed or class results.

CURVES OF TYPING ERRORS

1. *Artificial penalizing of speed gains.* Pale fires of controversy light your approach to the curves of errors. This is because accuracy in detail is still so overvalued at the expense of higher speeds. In the guise of hapless low marks, this bias carries a personal blow against whoever happens to be a faster but less accurate student. Marks, as estimated by teachers, whether in typewriting or any other subject, are often so unreliable that little trust can be reposed in them. Nevertheless, Ackerson[46] has worked over a collection of marks scored by New York high-school girls over three years of typewriting. He goes on to reveal that the relationship between typing marks and actual accuracy is very low (.45), but that between marks and speed it is still lower (.31). Isn't this little or no reliability? Even for the same student, discrimination against speed grows complicated as his "official" grades are shuttled up and down. Not only marks dealt out, but even the International Contest Rules for scoring speed tests, operate heavily to favor accuracy.

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[45] Kjerstad, *op. cit.*

[46] Ackerson, Luton, "A Correlational Analysis of Proficiency in Typewriting," *Archives of Psychology* (Columbia University, 1926), Vol. XIII, No. 82.

2. *Appearance of errors due to chance.* Consider 3648 typed papers gathered by Ackerson[47] from 304 New York high-school girls completing their final year of typewriting. These represent twelve 4-minute speed tests written at a usual speed of 46 gross or about 34 net words per minute. This elaborate study shortly demonstrates that the counted errors a student perpetrates in any half of her tests are little related to errors in the other half of her tests. Here enters chance. This relationship between error counts from different parts of the same student's typing is low (.54). It is the relationship between total *gross* words typed by each girl which is high (.99). What happens to these consistent gross scores when penalties are assessed? A 1-word penalty per error brings down the reliability (to .90). A 5-word penalty per error lowers this still further (to .80). A 10-word penalty lowers the reliability still more (to .69). This lessened relationship, when penalties for errors are applied, drops with the extent of the penalty, owing to the fact that more or less error intrudes by chance from accidental interference. Shouldn't you expect Butsch[48] to find the relationship between gross and net speeds to be only .78 in his own carefully charted practice? These signs that *net* scores are an artificial compromise between two little-related items recur in comparing typewriting skill and general ability tests. The I. E. R. General Clerical examination is such a test. Its scores hold a very slight relationship with speed (.27), but none at all with accuracy.[49]

The picture thus sketched of errors as injected time and again by chance factors that have scant relation to rising gross speeds is most clearly apparent with word errors. Quite obviously the interference behind omitted, added, or repeated words can be due to factors quite unrelated to the general run of typewriting. If more than one error is charged against such a lapse, even with two or more words involved, the reliability of the penalty must fall sharply.[50]

3. *Curves of gross and net scores.* Error penalties need not distort the classroom records. Their real value lies in their effects on your

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[47] Ackerson, Luton, " A Correlational Analysis of Proficiency in Typewriting," *Archives of Psychology* (Columbia University, 1926), Vol. XIII, No. 82.

[48] *Op. cit.*

[49] Ackerson, *op. cit.*

[50] *Ibid.*

morale. The International Contest penalty is an incentive away from annoying net scores towards the personal satisfaction of superior, known results. Its artificial absurdity of less-than-zero scores, moreover, is avoided in Blackstone's scoring, which lessens the successive penalty for each additional error in a test.

It helps to keep a record of gross scores, too. Between usual speeds and number of errors there is no genuine relation in *practice curves*.[51] The fast typist tends to be either accurate or inaccurate. Errors and speed rise or fall independently. Already you have looked over the second-year learning curves in Figures 24 to 26.[52] In these you have seen daily ups and downs in net speed that largely prove independent of wide daily variations in errors. When your net speed fairly follows rising and falling of the gross speed, this mirrors the familiar fact that typing more slowly or much faster than your accustomed optimal pace probably increases errors. The penalizing of speed scores is aptly labeled "artificial loading." Yet even an arbitrary penalty is grounded in real time wasted to erase or recopy an error in some busy office of the workaday world. Will you watch your own curve of gross typing-test scores mount? Will a second curve, of net scores only, follow the first? Doesn't it seem that a separate curve of errors is likewise highly desirable?

4. *Individual curves of errors.* You have already read Towne's [53] own story of her learning curve. A companion curve of errors is shown in Figure 28. Let this psychologist briefly continue the story:

> My error curve, based on material of increasing difficulty, showed only a very gradual decline. One error would be followed by confusion and several other errors. After the 60th practice, however, the dance of errors noticeably flattened out.
>
> In my second practice series there was less confusion after an error. Before continuing the line, more insight at this time usually helped me to get possession of myself. My error curve remained at the same level, until I put emphasis on accuracy. Then it decreased toward a vanishing point. As soon as this emphasis was removed, it again reached the usual narrow level maintained through most of my advanced practice. I therefore

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[51] Thurstone, *op. cit.*
[52] Butsch, *op. cit.*
[53] *Op. cit.*

seemed to have a level for errors which could be reduced at the cost of speed. The material was of the same difficulty, and my errors fell within a narrow range.

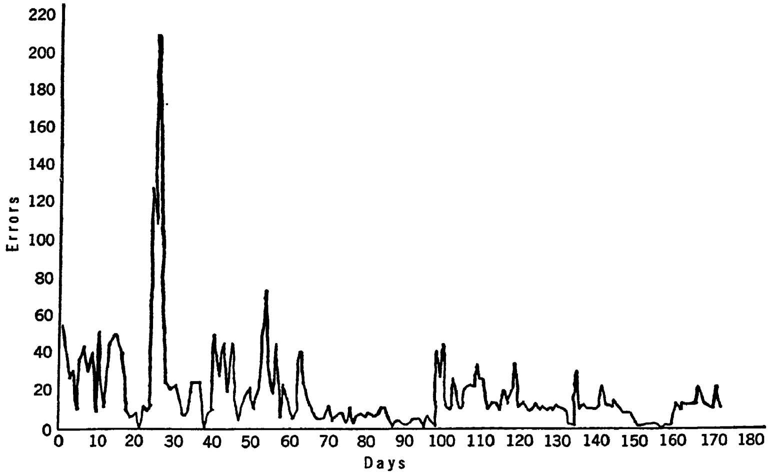

Figure 28. CURVE OF ERRORS DURING PRACTICE BY BLANCHE M. TOWNE[54] UPON A PORTABLE TYPEWRITER

YOUR TYPING PROGRESS CHARTS

1. *Recording your test scores and errors.* A workable progress chart, then, should include: (1) your curve of gross scores, (2) your arbitrary curve of net scores, and (3) your curve of errors. The progress chart in Figure 29, page 450, is arranged to enhance in graphic fashion this knowledge of your results. Of course, the data you need from each test are its date, gross strokes, total typing time, and errors, in order to find not only gross strokes per minute, but also net strokes per minute. Every typing student is highly aware of the celebrated 50-stroke penalty per error, which includes also the spacing when counting words as 5 strokes each.

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[54] *Op. cit.*

(1) Upon your progress chart (Figure 29) you plot your gross words per minute for each test. This line of gross scores rises with every increase in your speed.

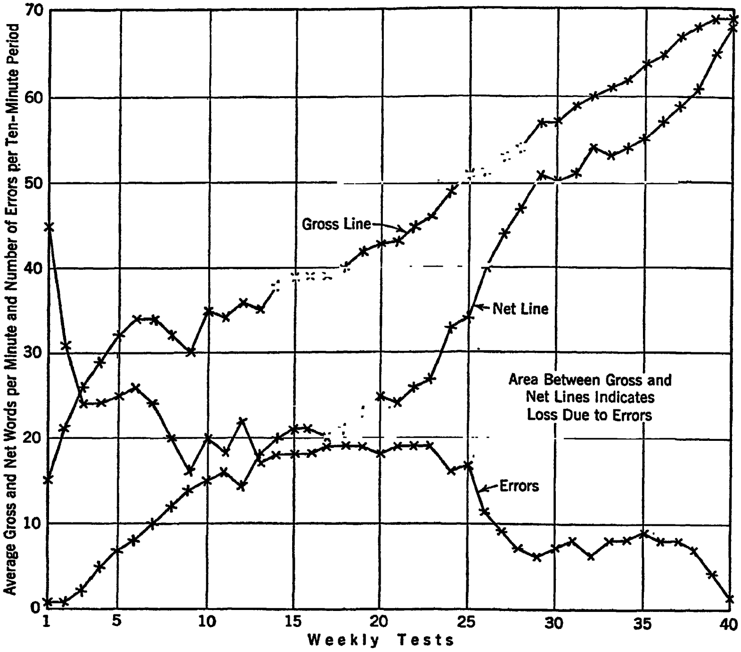

Figure 29. YOUR OWN PROGRESS CHART

(2) Upon the chart you plot also your net words per minute for each test. This line of net scores leaves the "o cellar" and climbs nearly to overtake the gross scores. The more accurate your typing, the closer do these two learning curves merge.

(3) Upon this chart you then plot your errors after each test. This line of errors should fall as errors decline. The more your errors vanish, the further below the two learning curves do you place your error curve. Conversely, excessive errors stand out *above* these two learning curves.

At once you can visualize concretely in balanced fashion the changing speed and accuracy of your typing outputs.[55–60] You can visualize how different writers and teachers have been attempting to enable you to utilize each measure of your success to stimulate you to greater success. Even more than you appreciate, your enthusiastic co-operation in the typing class depends on this very definite knowledge of the results. If you have any doubts, glance at the cross-sectioned visualizing board devised by the Gilbreths [61] to aid the blind typist.

If your own test scores are not immediately available, you may want to chart the actual scores of other typing students for the sake of practice in preparing such curves. Here are the fluctuating scores each minute, daily or weekly, of three beginner typists:

Chart-plotting Exercise — Jack C., Weekly 10-Minute Typing-test Scores

Gross Words . .	12	13	14	16	18	19	20	24	25	27
Net Words . . .	7	10	13	13	14	16	18	23	21	24
Errors	5	3	1	3	4	3	2	1	4	3

Chart-plotting Exercise — Deborah V., Weekly 10-Minute Typing-test Scores

Gross Words . .	24	24	26	30	31	32	33	47	34	33
Net Words . . .	0	4	0	9	9	25	14	19	24	22
Errors	24	20	26	21	22	7	19	28	10	11

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[55] See the " Progress Graph for Timed Tests " in SoRelle, R. P. and Smith, H. H., *Gregg Typing Techniques and Projects* (Gregg Publishing Company, 1931).

[56] See Smith, H. H., "The Teaching of Typewriting," *American Shorthand Teacher* (1930), Vol. XI, p. 100.

[57] See also Harned, W. E., *New Typewriting Studies* (Ginn and Company, 1930), pp. 43–44.

[58] See also Wiese, E. G. and Coover, J. E., *The Wiese-Coover Kinesthetic Method of Learning Touch Typing* (The H. M. Rowe Company, 1927), "Calculating Records," pp. 21–22; "Illustrative Practice Curves," p. 89; comparison between student's curve and class median, p. 99.

[59] See also Hakes, A. B., "Speed and Accuracy Graph" in *Typewriting Speed Studies* (Gregg Publishing Company, 1928).

[60] See also Slinker, C. D., "Typewriting Diagnostic Chart" (Gregg Publishing Company).

[61] Gilbreth, F. B. and Gilbreth, L. M., *Motion Study for the Handicapped* (George Routledge and Sons, 1920), illustration, p. 156.

Chart-plotting Exercise — Daniel D., Daily 10-Minute Typing-test Scores

Gross Words	13	14	13	17	20	19	25	23	22	26	25	27	25	29	29
Net Words .	6	10	8	11	11	7	17	10	17	13	11	9	13	16	20
Errors . .	7	4	5	6	9	12	8	13	5	13	14	18	12	13	9
Gross Words	34	26	28	28	22	28	25	28	28	29	27	27	27	29	30
Net Words .	16	9	13	20	4	8	12	17	15	18	10	7	15	19	23
Errors . .	18	17	15	8	18	20	13	11	13	11	17	20	12	10	7

2. *Class scattergrams and class curve.* Suppose that after the speed test a class committee plots together on the same progress chart the scores of every student in gross words per minute, rising from left to right on the chart, and the total errors, rising from top to bottom. The immediate effect will be that of a "scattergram." Most of the scores will be bunched about an invisible line rising across the chart. Some few scores will fall well outside the rest. Dead lines may be ruled directly on the chart to exclude these few lowest speed scores and highest error scores.[62] Any students whose scores fall outside these dead lines automatically are marked for special attention.

The class committee now holds collected all the scores from every student typist. Suppose the committee then arranges these scores in order from the highest to the lowest, then counts down (or up) to the middle score. Any middle score is taken as a class median.

(1) All the gross scores are arranged in order, and the middle gross score per minute is then taken as the class median.

(2) All the net scores are arranged in order, and the middle net score per minute is then taken as the class median.

(3) All the error scores are arranged in order, and the middle error score is then taken as the class median.

On another progress chart only these median class scores are then plotted. For each successive class test, such median scores are placed on this master chart. Here the class curve for gross scores and the class curve for net scores gradually rise. Here the class curve for errors gradually sinks. Every student can now compare this class progress chart with his own progress chart and ask himself, "Where do I stand in this group? Am I slower? Am I about average? Am I faster?" Through these rising curves, a picture of the entire class and its progress and of you and your progress can be visualized at a glance.

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[62] Compare the dead lines ruled upon scattergrams in Slinker, C. D., "Testing as an Aid in Teaching Shorthand and Typewriting," Monographs in Education, First Series, No. 8, *Research Studies in Commercial Education* (University of Iowa, 1928), Vol. II, pp. 98–111.

3. *Use of bar charts.* In like manner, charting bars in place of curves always gives a more vivid picture than mere numbers. Both class and individual test scores are easily transformed into bar graphs. You will enjoy manipulating "motivation" bar charts [63] if these are available. These charts are ruled in vivid red or deep black into 100 spaces for bar strips. The strips are started with a knife and pulled out to the desired point. In Figure 30, page 454, you see at a glance the picture of an entire typing class and all differences, startling or otherwise, between the net speeds of separate students. An even keener incentive is for you to pull out your own bar strips as you improve test by test. The concreteness of this individual "motivation" chart is clear in Figure 31, page 455. The typewriting workroom has frequently surpassed all other classrooms in this vivid equipment to ensure practical outcomes.

If the typing work is assigned in definite budgets or blocks, Kurtz [64] suggests a motivation chart that can readily be typed. Each of the projects or exercises for the period of the budget is given its own bar. As fast as any project is completed, its bar is filled for the remainder of the contract time. That is, the remaining balance of its bar is typed in by repeating *m* or another solid letter. Thus you see your progress day by day through the complete unit and know just what proportion of your contract still lies ahead. Figure 32, page 456, presents such a budget of ten typing projects running for ten days, with six completed on its fifth day. When you grow skillful in making your own curve and bar charts, you profit from the full stimulation by the incentive known as *knowledge of results.*

4. *Your monthly line-production output.* Not only speed scores and errors, but also your weekly and monthly *line-production* outputs

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[63] "Typewriting Progress Chart," sample set, Motivation Charts, Inc., Jewell, Iowa.

[64] Kurtz, A. K., "A New Type of Motivation Chart," *Journal of Educational Research* (1931), Vol XXIII, pp. 238–240.

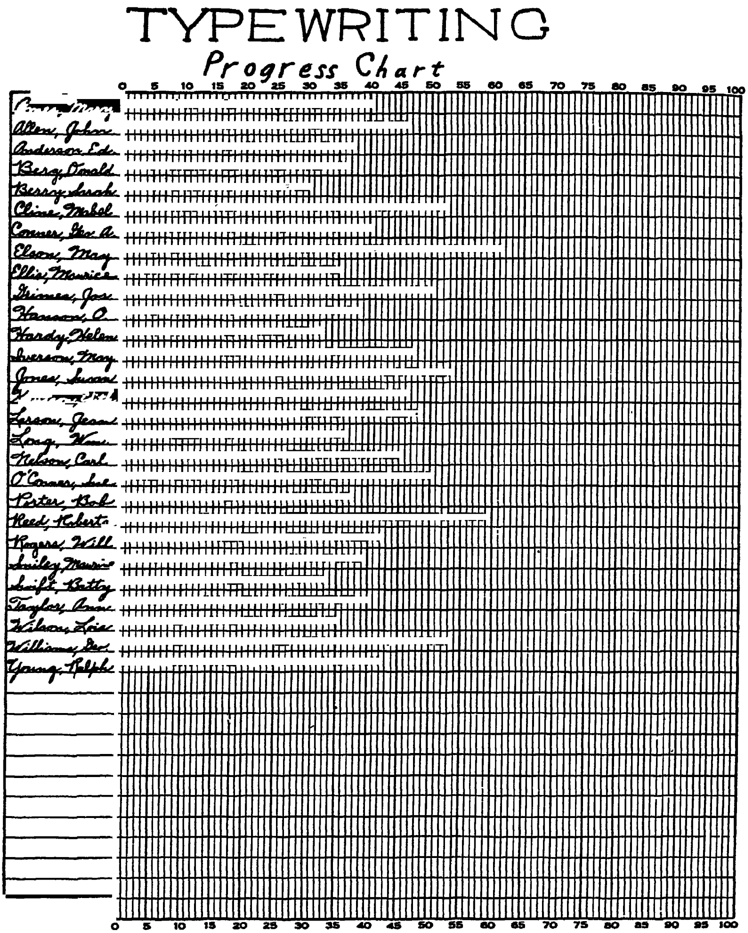

Figure 30. "MOTIVATION" BAR CHART FOR TYPEWRITING CLASS [65]

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[65] "Typewriting Progress Chart," sample set, Motivation Charts, Inc., Jewell, Iowa.

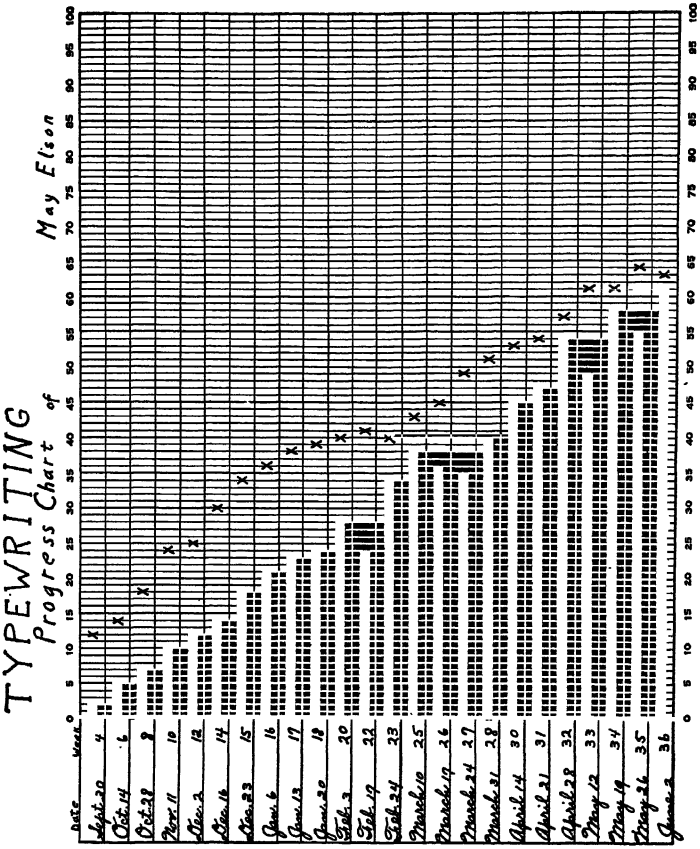

Figure 31. "MOTIVATION" BARS CHARTING COMPETITION BY AN INDIVIDUAL STUDENT TYPIST AGAINST HIS OWN RECORD[66]

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[66] "Typewriting Progress Chart," sample set, Motivation Charts, Inc., Jewell, Iowa.

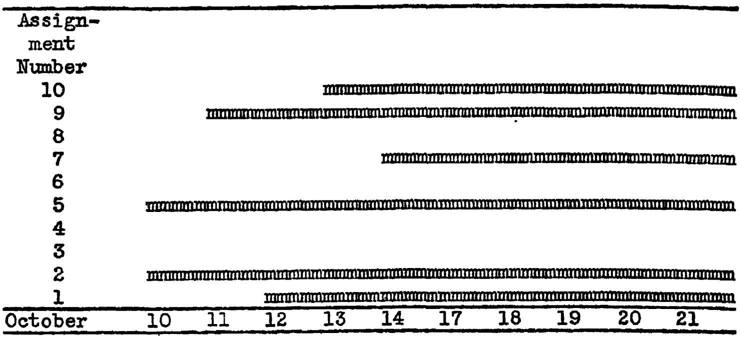

Figure 32. SAMPLE OF TYPED-BAR CONTRACT CHART
(From Kurtz [67])

lend themselves to bar diagrams readily typed. Your line-production output can be taken from a simple daily record like Figure 33 below. A concrete *memo* like this is easily jotted down. It reduces records to a desirable minimum, yet favors the study of errors in their actual line settings. This simple, daily record will soon show not only how fast your output is growing, but also how much more accurate your typing becomes. To count by lines, try to set your usual margins each day for the same line (such as 60 spaces). Because typing often falls or rises curiously day by day, it is best to compare only total accurate lines for each week or every four weeks. You can see just what is happening much more clearly after you turn these numbers into bars, thus:

Date	Lesson Number	Number of Accurate Lines	Number of Inaccurate Lines	Total		Grades
				Lines	Errors	

Figure 33. DAILY STUDENT RECORD OF LINE-PRODUCTION OUTPUT

Suppose for every four weeks you count lines until you have typed 608 with 64 inaccurate lines, 688 with 48 inaccurate lines, 800 with 16 inaccurate lines. These numbers are too large to make a handy bar, so divide them all by any number large enough to cut all these numbers down. Thus, you might divide by 16.

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[67] Kurtz, A. K., " A New Type of Motivation Chart," *Journal of Educational Research* (1931), Vol. XXIII, pp. 238–240.

Now you have simpler numbers, such as 38 to 4 inaccurate lines, 43 to 3 inaccurate lines, 50 to 1 inaccurate line.

For the four weeks in February, type *m* 34 times, then add the 4 inaccurate lines by *o* typed 4 times. If you have a black and red ribbon, add this contrast.

For four weeks in March, type *m* 40 times, then add the 3 inaccurate lines by *o* typed 3 times.

For four weeks mostly in April, type *m* 49 times, then add the 1 inaccurate line by an *o*.

4 weeks, Feb. 608 mmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmoooo

4 weeks, Mar. 688 mmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmooo

4 weeks, Apr. 800 mmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmo

Figure 34. SAMPLE OF A MONTHLY TYPED-BAR CHART

The direction that your line outputs are taking quickly grows visible on the bar chart.[68] As the typewriting advances into the more diversified forms, such as book work, tabulations, stencils, letters, and speed tests, more elaborate charts made up of parallel or mixed bars or else of varied, parallel curves, all in contrasting colors, follow these different line-production outputs at once.[69]

When all is said and done about incentives, the last word on rapid improvement remains with competition against your own record. The more you know about the records being made, the surer does your personal efficiency climb. To know that you are a success as a typing student becomes your best incentive.

INTERPRETATIVE SUMMARY

All flexible experimenting with better typing motions is lent stability throughout by setting up standard outcomes. As a result, the entire course is shaped as a field of forces moving toward the desired result. Each successive typing improvement follows its invisible gradient, or line of decreasing action, to its definite goal. This outcome is made standard by measurements. Student records of these measured typing outcomes contribute the basic incentive — *knowledge of results.*

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[68] See also Chamberlin, J. E., "Typing Graphs," *Balance Sheet* (1929), Vol. XI, pp. 70–77.

[69] Ford, G. C., "The Line Method of Measuring Outputs in Advanced Vocational Typewriting," *Sixth Yearbook* (Eastern Commercial Teachers Association, 1933).

In self-directed practice, individual charting of the consequences becomes a spur to desired changes. Since the exact difficulty of most typing assignments is not yet known, the widening area of typing skills is charted simply as altitude by a rising line. This single progress curve is thus a compromise that lumps both simple and difficult achievements. While there are physical limitations to the latter, usually a lack of incentive to further practice sets improvement limits well below highly skilled operation at 100 words a minute.

There is no typical learning curve that fits all typing students. At the outset, the test scores rise somewhat more steeply either up a curved or a straight-line slope. Any changes in practice material help to shift its form. Daily and weekly fluctuations often obscure its upward slope. These erratic ups and downs are not essential, but instead invite probing to uncover the causes. This invitation to pointed student comment in diary form is a by-product more important than the curve itself.

During excessive fluctuations the upward trend may cease. Such plateaus are not essential. Their arrest may be due to a "breathing space" that reflects a slump in physical condition, interest, or effort. More often such plateaus mirror the heightened suspense and confusion while facing new difficulties. Much advanced conventional practice, following early excess drills on isolated letter stroking, is aptly pictured as "plateau blues." Better teaching materials, a less difficult keyboard, more ingenuous management, and problem solving should eliminate these plateaus of other days.

A separate curve of errors is needed, since many typing-class marks and also the International Contest scoring rules show a heavy bias in favor of accuracy. The relationship between gross scores of a student is high and reliable, but this reliability becomes lower the heavier the error penalty assessed. This is because more or fewer errors intrude by chance from accidental interference. Net scores become an artificial compromise between the unrelated items of speed and of accuracy. The International Contest penalty based on final office accuracy is valued for its effects on student morale. Even its artificial absurdity of less-than-zero scores is avoided by the Blackstone test scoring.

Each workable student progress chart includes (*a*) this declining curve of errors and (*b*) a rising curve of gross scores, approached increasingly by (*c*) a rising curve of net scores. By plotting all class scores, dead lines may be drawn to exclude individual test results calling for special attention. By plotting each median class score, a master class progress chart is built for any student's immediate self-comparison with his group. This class progress curve inevitably blankets individual student differences. Not only speed scores and errors but also varied weekly and monthly line-production outputs lend themselves to vivid bar charts. The more the student knows about the minimum of records being made, the more definite is his reinforcement of conditioning to correct, fast motions.

CHAPTER XVI

WHAT MEASUREMENTS SHOW

* * *

READING SUGGESTIONS

To the Student Typist: View typing as made up of levels, pages 461 to 463. Work your typing difficulties into new-type questions, pages 463 to 469. Read why you should keep a typing diary, pages 469 to 471. Read pages 471 to 476 only to catch the idea of self-study of your difficulties by special practice exercises. Briefly review errors and their penalty, pages 477 to 479. Discover what standard typing material is, pages 479 and 480. Catch the idea of standards in office work, pages 480 to 483 and 490 to 496, and in your classroom, pages 483 to 487. Understand Blackstone's examinations, pages 486 and 487. If you also transcribe, read pages 487 to 490. Overview the use of measurements for a case study of yourself, pages 490 to 499.

To the Psychology Student: This chapter brings you to the exact measurements which, with experiment, make educational psychology a science. Notice first the present culmination of the testing movement in diagnostic tests, using standard practice materials to reveal a weakness and apply the remedy, pages 471 to 476, 485, and 490. Notice why the stress on student attitude and feeling makes the student diary more important than artificial course marks, pages 469 to 471. In passing, you will be interested in the short summary of motor-ability tests, pages 463 to 466. Notice, incidentally, why students should make new-type examinations, pages 467 to 469. Review the usual distribution of student scores and its criticism, page 477. Read to understand what is meant by standard samples, page 479, and by the way survey tests are made standard, pages 483 to 485. You may be interested in motion and time study applied to standard work units in business offices, pages 480 to 483 and 485. Read the brief summary of relationships between typing and standard tests of intelligence, English, spelling, and the like, pages 490 to 492. Skim rapidly the use of many measurements in an individual case study, pages 492 to 495. Notice the final statement concerning attitudes, pages 501 and 502. Is your final outcome a mastery that *applies* this new knowledge with the least time and energy?

To the Typing Instructor: High points of this chapter are, first, finding of diagnostic practice materials, pages 471 to 476; and, second, your use of student diaries, as supplementary to marks, pages 469 to 471. The latter implies conference methods, pages 470 and 471. Notice also student use of new-type tests, pages 467 to 469. The rest of the chapter presents various typing standards and tests, pages 479 and 483 to 490. In advanced typewriting, important items are part-time employment experiences, with follow-up, pages 496 and 497; and case studies of typists in specialized fields, pages 497 to 499. Add the interpretative summary, pages 499 to 502.

* * *

LEVELS OF TYPEWRITING SKILLS

If portable typewriters for young children are to be lively incentives that instill a new enthusiasm for more prosaic school projects, if most other students are also to add typing as an essential item of their everyday living, and if the typewriter is to be everywhere the American substitute for the sluggish pen and pencil, there is little pressing need for prior tests that will separate fit from unfit typists before the typewriter is even touched. This is fortunate, for such a separator has never appeared. With typewriting general among junior and senior high-school youth, actual samples of typing performance will probably remain the most effective device for determining whatever personal aptitude more advanced typing levels demand.

Meantime, the progress chart bears witness to the rising altitude of your typing. There are three practical levels of altitude, according to Director E. W. Barnhart of the Commercial Education Service, Federal Board for Vocational Education.

(1) You will first want a typewriter for your personal letters and other written productions, clicking along at rates faster than pen or pencil (which might mean only 25 words a minute). This is *personal* typewriting.

(2) As speed and facility increase, your skill becomes an incidental tool for occasional office typing in the midst of other work. This is *general business* typing.

(3) If you persist, your typing at last is sufficiently specialized to become a major tool for earning a living within office walls. Any minimum speed, such as 45 words a minute, still would hardly be

fast typewriting. Yet such a supply of trained motions, if it matches the standards set for hourly outputs in better business offices, is adequate to be *vocational* typing.

A picture of the practice to be accepted or tossed aside in the light of these differing interests is sketched for you by Reynolds.[1]

Personal typing. Within one semester you will want to know how to operate, clean, oil, even change ribbon, using an up-to-date typewriter. You will master its keyboard. You will practice manuscripts, arrangement of bibliographies, and the making of good-looking notebooks. Perhaps you will add two standard forms of letter arrangement and good style in addressing envelopes. You will write original compositions directly on the typewriter, because you will want to make this machine as much a part of your thinking as pen and pencil have been. On straight copy, your final speed should equal from 25 to 50 net words a minute, according to the keyboard used. This result assumes successful instruction and normal aptitude. Sooner or later all your writing will be conditioned on your favorite typewriter and without it you will feel "lost."

General business typing. A natural setup of typing studies should elevate you after one year or less to the levels of skill necessary for random office uses. You will wish a wider acquaintance with letter forms. You will also practice duplicating, fill in forms, type cards, and take dictation at the machine.

Vocational typing. If you elect typewriting for its cash value in maintaining your livelihood, the final outcome of more advanced studies will be transcribing, from machine dictation or shorthand machine or shorthand, all types of letters and business papers. You will grow skillful in handling rough copy, even in making tabulations. In practical typing jobs you will sample the day's work of some office. You should profit from practice material drawn from case studies of typists' work in the very line of business which you plan to enter.[2] Your supply of motions, however successful with straight copy, will thus be transformed to meet daily standards in a modern office. Indeed, your advanced typing studies should simplify and make these new motions practical through satisfying part-time experiences in an actual office.

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[1] Reynolds, Helen, "Typewriting — A Subject to Be Taught," *Proceedings* (National Education Association, 1930), Vol. LXVIII, pp. 289–291.

[2] See, for example, fifty jobs in the office of an automobile supply and accessory business, by Reigner, C. G., *Typewriting Office Practice* (H. M. Rowe Company, 1932).

The entire typewriting field seems on the verge of far-reaching improvements, which will drastically shorten the learning periods required for faster personal and standard office typing. In brief, as you and your comrades travel these three branching paths, your typewriting improvement should be measured as it will be used amid the later realities of life outside school walls.

MOTOR-ABILITY TESTS

A weird parade of artificial mental tests is persistently chaperoned by psychologists as scientific aids for determining typewriting aptitude. Some are suggestive: from separating slight differences in lifting weights and in fineness of sense of touch to reproducing sentences immediately after reading, carrying out certain directions, and the inevitable spelling test.[3–4] The somewhat antiquated correlation tables, often grasping at the slightest straws, are exceedingly dry reading which you will be happily spared. These formal tests with their rather slight relationships to typing success can scarcely compete with actual samples of typewriting performance.

Tests of your ability *before* typing starts seem most promising in the field of motions. Obviously you need distinct muscular ability, known as motor ability, to become a superior typist. It is not unlikely that motor-ability tests may help select very superior or very inferior typists from the very start. Best known is the tapping test devised by Bryan[5] and applied to champion typists by Book.[6] You hold your finger in horizontal position and with the finger end

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[3] Muscio, B. and Sowton, S. C. M., "Vocational Tests and Typewriting," *British Journal of Psychology* (1923), Vol. XIII, pp. 344–369.

[4] Johnson, C. L., "The Validity of Certain Tests to Prognosticate Typewriting Ability," Master's Thesis (University of Iowa, 1925).

[5] Bryan, W. L., "On the Development of Voluntary Motor Ability," *American Journal of Psychology* (1892), Vol. V, pp. 1–80.

[6] Book, W. F., "Voluntary Motor Ability of the World's Champion Typists," *Journal of Applied Psychology* (1924), Vol. VIII, pp. 283–308.

tap a telegraph key connected to a counter. If you have studied typing, interference arises from this horizontal finger position, since in typewriter stroking the finger is kept curved.[7] Tapping is not typing. The telegraph key is tapped first with the forefinger, then with the hand, using the wrist as a hinge, then with the forearm, without using the wrist, and then with the upper arm, including the shoulder muscles. Your scores are compared with the usual scores made by others of your age. Book shows the typing champions outstanding in this comparison. The right hands of Albert Tangora and George Hossfield are 32% and 33% superior, and their left hands are 28% and 41% superior to the usual scores by men of like age. This superiority of the more outstanding typewriting contestants Book has massed in the following table:

TABLE XLIII

PER CENT OF SUPERIORITY OVER CORRESPONDING AGE NORMS IN EACH MEASUREMENT OF TYPEWRITING CHAMPIONSHIP CONTENDERS
(From Book [8])

Contestant	Left				Right				Words per Minute
	Forefinger	Wrist	Elbow	Shoulder	Forefinger	Wrist	Elbow	Shoulder	
World champions	32	30	43	31	24	31	44	30	**146**
Ex-world champions	26	23	19	30	24	30	20	21	**135**
Amateurs .	16	21	13	16	11	11	6	8	**124**
School champions	8	3	12	12	13	17	14	22	70

When this motor-ability test is applied to the bulk of typists, however, its selective value becomes slight. Twenty-five commercial typists have been measured by Kitson,[9] and their scores have been compared with those of 50 girls who are not typists. The average score of these girls is 49 and of the typists, 52. The usual difference between the typists and untrained girls is but 2 to 4 points. Experienced pianists show less difference. Even in his group of 22 typing students rated superior, Book notes that their average of some 6 strokes a second is also the speed of average unselected beginners. For these reasons, this tapping test is serviceable chiefly at the extreme limits of ability. Most tapping tests show little relationship with typewriting.

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[7] Kitson, H. D., "Determination of Vocational Aptitudes," *Journal of Personnel Research* (1927), Vol. VI, pp. 192–198.

[8] *Op. cit.*

[9] *Op. cit.*

It is a mistake to imagine that there is some general motor capacity of which you or some other students possess much and yet others possess little.[10] On the contrary, if motor-ability tests are to aid in selecting the future skilled typist, then exactly the motions used in typewriting need to be tested. It seems to take actual typewriting samples to raise a relationship as high even as the .60 mentioned by Burt.[11] His tests have included typing from memory, typing from clean, rough, or illegible copy, and arrangement of display. Have you ever turned a hand to trade and mechanical tests that accompany shopwork? Mechanical ability seems extremely illusive. Most such concrete acts apparently do not concern typewriting. In the MacQuarrie test of mechanical ability, skill with a pursuitmeter is related but .38 to typing speed and not at all to accuracy.[12] Or suppose you should try the twisting, thrusting, and clasping hand movements needed to manipulate bolts and blocks in the Crockett test of manual ability. Crockett[13] himself hastens to separate three essentials as distinct: expertness and grace in a manual act, ability to think in spatial patterns, and ability to understand and manage mechanisms. Tests of mechanical ability, such as Earle and Macrae[14] describe, are indeed less related to manual dexterity than to grasp of mechanical principles and spatial relations. Despite the building of many clever tests, of which you can consider the Stanford motor-skills unit[15] as typical — adding the familiar pursuit of a target, hand-drill work, repeated rhythm, and other tests to telegraph tapping — not one reflects typing aptitude. This is unfortunate, since working these ingenuous contrivances often injects a fascinated interest into the ordeal of being tested. No matter how clever or clumsy you are with most mechanical things, there is only one test of your present fitness. Are you actually making all necessary motions from first placing paper in the machine to twirling out the finished typescript?

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[10] Muscio and Sowton, *op. cit.*

[11] Burt, C., "Tests for Clerical Occupations," *Journal of the National Institute of Industrial Psychology* (London, 1922), Vol. I, pp. 23–27, 79–81.

[12] Stedman, M. B., "A Study of the Possibility of Prognosis of School Success in Typewriting," *Journal of Applied Psychology* (1929), Vol. XIII, pp. 505–515.

[13] Crockett, A. C., "A Measure of Manual Ability," *Journal of Applied Psychology* (1930), Vol. XIV, pp. 414–425.

[14] Earle, F. M. and Macrae, A., "Tests of Mechanical Ability," *Report*, No. 3 (National Institute of Industrial Psychology, London, 1929).

(1) Some students read copy faster than others.

(2) Some students feel more surely than others the spatial form of the keyboard with its rows of keys in an inclined plane.

(3) Some students understand better the how and why of the working parts inside a typewriter.

(4) All this is quite different from expert grace in keeping your hands in motion.

You need so many unique skills that it is easier to work them all together and think of "typing." So complicated are the motion patterns in typewriting that even actual use of a typewriter need not reveal the likelihood of correct typing movements. In such a motor test of serial-action speed, you are given different signals for *y*, *t*, *u*, *i*, and then stroke the appropriate typewriter key swiftly to each signal. Until you complete a stroke, the apparatus does not give you the signal for the next stroke. This delay prevents the overlapping typical of typewriting sequences. It is not at all surprising that Hanson[16] could uncover no genuine relationship with a typewriting test or even with a typing instructor's estimates of his students. The scores of 176 student typists on this motor test were of no importance, with merely a relationship of .15 for typing speed and only .10 for typing accuracy scores. With increasing refinement, however, perhaps by electrical measurements, the future of motor-ability tests is still open.

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[15] Seashore, R. H., "Stanford Motor-Skills Unit," *Psychological Monographs* (Princeton University Press, 1928), Vol. XXX, pp. 51–66.

[16] Hanson, C. F., "Serial Action as a Basic Measure of Motor Capacity," *Psychological Monographs* (Princeton University Press, 1922), Vol. XXXI, pp. 320–382.

NEW-TYPE OBJECTIVE EXAMINATIONS

Before bringing up your measurement by typewriting samples, consider the many details of typing improvement that can be checked by the usual new-type school examination. You have already profited from many such definite checkups of gaps in your knowledge. Just as writing your own text requires original thinking about typing problems, so the making of these new-type examinations can take you to the very heart of typing difficulties and their surrounding details. What naturally follows the first acquaintance with typewriters or even reading about paper insertion, carriage, margin and scales, tabulation, ribbons, cleaning of machines? What naturally follows the talking over and trying out of machine operation, aided by a master typist's demonstration? Isn't it to work things out for yourself? Here is where you start to try out your questions on the machine, to see what answers have value. Here is where you commence at once to work out lists of "true-false," "matching," and problem questions in review of your machine operation. It is not overtedious for you to help a teacher systematically to construct such "multiple-choice" and "true-false" tests by slowly building up, term by term, a file of questions and eliminating any that the class finds too simple or too difficult. As a basis for this experimenting in making up these new tests, which are scored so simply, definitely, and yet impartially, adequate samples are presented by Lomax:[17]

Multiple-choice Test

Directions: Underline the word or phrase that makes the correct answer.

1. There should be a (single, double, triple) space between the last line of the body of a single-spaced letter and the complimentary close.
2. In the complimentary close, the first letter of (the first word, each word, the most important words) should be capitalized.

If the possible choices in such questions are increased from three to five or more, with any number of these correct or incorrect, the difficulty is so increased that very simple items may be checked. These more elaborate multiple-choice questions can then determine to a nicety whether your correct responses are due to accidental, superficial, or thorough knowledge of the material involved. These tests do not require much of your time, hence the thoroughness of your knowledge can be determined by using a large number of items.

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[17] Lomax, P. S., "Testing Teaching Results in Typewriting," *Journal of Business Education* (1929), Vol. III, pp. 20–22, 44.

True-false Test

Directions: Underline the word "True" if the statement is correct. Underline the word "False" if the statement is incorrect.

1. There should be a double space between the last line of the body of a single-spaced letter and the complimentary close. True False
2. In the complimentary close, only the first letters of the most important words should be capitalized. True False

Among decidedly less important forms of new-type examinations are listed matching tests.

Matching Test

Directions: Read each phrase and then find the name of the typewriter part at the left with which the phrase is associated or which it fits best. Record the number of the proper part in the parentheses in front of each phrase.

1. Line-space lever
2. Line-space adjusting lever
3. Line-space disengaging lever
4. Carriage-release lever
5. Tabular stop
6. Tabular key
7. Front scale
8. Cylinder scale
9. Tabular scale
10. Marginal-release lever or key

(10) To write outside the marginal stops without readjusting the marginal stops.

(8) To aid the typist when he adjusts paper in the machine, when he fills in blanks, when he centers, or when he straightens paper in the machine.

(3) To aid the typist in writing on ruled lines and make it possible to have irregular line spacing rather than single, double, or triple spacing.

Simple Recall[18] *and Completion Test*

Directions: Write on each blank line a word or a short phrase which will make the statement true.

1. When you insert paper in the typewriter, the left edge should rest against the paper guide.
2. When you remove paper from the typewriter, always use the paper-release lever of the typewriter.

Doubtless you have already experienced the well-known "Stuart Objective Tests in Typewriting,"[19] with added insight into both (*a*) the success of your own carriage throw, tabular stroke, and centering, and (*b*) the use of new-type tests within your field. If you are already familiar with the emphasis placed by Stuart on making your tabulating or carriage throw or centering and aligning real parts of the daily routine, until each grows automatic with the greatest possible saving of time, you will not be surprised at this useful intrusion of actual machine operation into these new-type tests.

STUDENT DIARIES

What do you think of less formal measures of your ability to analyze your own errors and methods, in short, to estimate your own improvement? Isn't it an admirable suggestion[20] that each student should demonstrate with each new semester an increasingly clear understanding of his own weaknesses and the remedies? To this end a card folder might well carry all your more important typewriting papers, together with your comments on what these papers show and how you feel about the course. This informal comment implies more than a personal laboratory pad. This would be your typing diary. Why should you have such a folder keeping your best work, and why such a diary?

The goal of your typing class is to create in yourself a co-operative, motion-study attitude. Your best work reflects this new attitude. Your diary allows you more fully to express this attitude in personal remarks. School records of the future will borrow this diary form. How else can student attitudes be fully expressed? What, in fact, is the only alternative? An outstanding typing authority, Smith, has clearly stated it.[21] Until your attitude is known, your guide or instructor must blindly demand "so many repetitions" of each error as a class routine. Only when you clearly develop the correct attitude can you be your own judge of the nature of your improvement drills and of how much practice you require to master each difficulty.[22]

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[18] Such as writing a definite list of items.

[19] Stuart, E. R., "Stuart Objective Tests in Typewriting," sample set (Gregg Publishing Company).

[20] Pulver, L. G., "Examinations in Typewriting," *Balance Sheet* (1926), Vol. VIII, p. 8.

This is why you have been asked to read so many pages in Part One — to discover how you feel about typewriting and the immediate world around you.[23] Otherwise little space would be accorded the roles you like in typewriting class, your attitudes toward the difficulties, and how you treat trouble indicators in the typewriting class. Changes in the social setting improve your typewriting because your typing attitudes follow these changes. The way you feel about these changes is the way you start to act.[24] Suppose you now comment feelingly about typing troubles and practice in a student diary. Does this mean added reams of red tape and written class reports? Perish the thought! Already you have your progress chart and simple daily record of line-production outputs. Doubtless you do keep your more interesting typed sheets. Only occasionally will you pause for a bit of personal stocktaking. Perhaps you check over your daily schedule for wasteful omissions.[25] Perhaps you see yourself confused at some point. You jot down concrete details of what is happening, of your counteraction, of how you feel about it all and about the typing class.[26] The diary is simply your own occasional comments on how you feel about the measured results of your typing and intruding difficulties. This pointed comment from yourself is more important than the official "marks" that encrust your school career. Do you agree? This interpreting of a personal typing difficulty continues until you dominate this side of the practice.

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[21] Smith, H. H., "Problems in Diagnostic Testing and Remedial Teaching as Applied to Typewriting," *Second Yearbook* (Commercial Education Association of New York City and Vicinity, 1932), pp. 53–68.

[22] *Ibid.*

[23] See pp. 17–45.

[24] Recall "Discovering Your Attitude," pp. 39–41.

[25] Compare the time diary, pp. 427–432.

[26] Recall "Definiteness of attack and planning ahead," p. 44, and the check list of "difficulties," p. 42.

The occasional class "conference hour" for the study of these personal difficulties elevates typewriting to the essential position of an academic course devoted to motion and time studies of ballistic stroking, balanced postures, paces and rhythm, efficient layouts for flows of work, and error or fatigue prevention. This newer typing class thus becomes the schools' closest popular approach to the *Scientific Management* that has so efficiently reshaped first the industrial shop and now the business office, by motion studies and superior standards for production. There is more fascinating applied science in the modern typewriting class than in most academic subjects. Here you learn, first, by watching a skillful demonstration; second, by typing conferences in which questions and answering suggestions are raised until superior operating plans are discovered; third, by applying this definite planning to actual typewriting; and, fourth, by a real checkup as the start of further planning. Your diary comments and the conference suggestions merge.[27]

DIAGNOSTIC TESTS TO UNCOVER YOUR DIFFICULTIES

Your self-study and appreciation of definite measurements taken of your typing results bring you into the heart of the modern testing movement. Up-to-date testing has swept far beyond the "perfect-copy" notion of older days. This still common "perfect-copy" check is also neatly deflated in Smith's[28] searching criticism, because it gives no information whatever concerning the kind of typing technique used or the fluency or speed of output. No wonder that classroom surfaces are as yet hardly scraped to uncover the definite interference behind repeated errors and wasteful retyping.

[27] See also pp. 427–432.

[28] *Op. cit.*

Widespread diagnostic work has thus far penetrated the typing class chiefly in the scoring and proofreading for errors of non-standard material. Because nobody knows exactly the nature and degree of difficulty of this practice material, reliance is chiefly placed on a detailed listing of obvious faults. Here is such a sample of detailed scoring for letter arrangement, worked out as a group project by students of Ford and Hoffman.[29] Possible faults are not only presented, but certain features are accented by a varying loss of credits. Somewhat similar penalties are also applied to typewritten transcripts.[30]

TABLE XLIV

SCORING DETAILS THAT STRESS CORRECT LETTER ARRANGEMENT[31]

General Instruction Sheet

		Number of Credits Deducted
APPEARANCE		
Appearance:	Poor ____ of letter due to faulty insertion of paper	2
Letterhead:	Failure to use specific ____ in pad	4
Margins:	*a.* Irregular or slanting left-hand ____ or grossly irregular right-hand ____	1
	b. Unequal or incorrect right or left ____	2
Neatness:	Lack of ____ or for any error not specified here	1–5
Placement:	Poor vertical ____	2
FORM		
Address:	*a.* Omission of inside ____	4
	b. Supplying an unnecessary ____ in heading	4
Business title:	Omission of ____ when required	2

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[29] From Reed, C. A., "Suggestions on the Conducting of Examinations and the Rating of Regents Examination Papers in Commercial Subjects," abstracted in *American Shorthand Teacher* (1928), Vol. IX, pp. 11–14, 51–54.

[30] Saslaw, Sadie, "General Diagnostic and Remedial Measures in Typewritten Transcript," Monographs in Education, No. 12, *Research Studies in Commercial Education* (University of Iowa, 1932), Vol. V, p. 83.

[31] Arranged by G. C. Ford and Doris Hoffman in a class project at San Jose State College, 1930.

TABLE XLIV — *Continued*

		Number of Credits Deducted
FORM — *Continued*		
Carbon copy:	Failure to submit ____ when required	4
Centering:	Error in ____	1
Company letter:	Omission or misplacement of name of person addressed in a ____	4
Complimentary closing:	Omission of ____	4
Date:	Omission of ____	4
Enclosures:	Omission or misplacement or faulty form of ____ when required	2
Heading:	Place repeated in ____	2
Indention:	Failure to ____ properly in but one instance; more than one error of this kind requires total deduction of 10 points for faulty use of form	2
Items:	Failure to indent properly and block column of series of ____ in body of letter	4
Letter subject:	Omission or misplacement of ____	4
Listed material:	Failure to double space before and after ____	2
Listed matter:	Failure to arrange ____ properly	4
Paragraph:	Failure to ____ properly in but one instance; more than one error of this kind requires total deduction of 10 points for faulty use of form	2
Paper:	*a.* Use of two sheets of ____ when one is necessary	4
	b. Two letters on one sheet	4
Spacing:	*a.* Failure to single space listed material in double-spaced letters	2
	b. Failure to double space between complimentary close and firm signature	2
Signature:	Omission of required firm ____	4
Style:	Ten credits should be deducted if student fails to use correct ____	10
TYPOGRAPHICAL ERRORS		
Erasure:	Use of ____	5
Line spacer:	Error in use of ____ (Maximum charge: 5 credits)	1

TYPOGRAPHICAL ERRORS — *Continued*		Number of Credits Deducted
Strike over:	Use of ___	2
Interlineation:	Maximum charge for ___ of four or more words: 4 credits	1
Wrong guide:	Use of ___ for a line	4
OTHER ERRORS		
Abbreviation:	Use of an incorrect ___	2
Hyphen:	Omission of necessary ___ at end of line	1
Names:	___ of recipient and sender reversed	4
Omission:	*a.* ___ of line or two consecutive words in line	4
	b. ___ of initials of dictator and stenographer	2
	c. ___ of repeated word or number, except where two or more consecutive words are omitted or repeated: then 4 credits should be deducted for the omission of each printed line of copy or fractional part of a line of copy	2
Punctuation:	Omission of or incorrect ___	1
Signature:	*a.* Typed or written ___ when it should be inserted	2
	b. Student signing letter without being so instructed	2
Underscore:	Omission of required ___	1
Unfinished word:	___ at end of line when word is repeated on next line	1
Words:	Incorrect division of ___ (use of dictionary allowed)	1

The newer straight-copy drills, such as White[32] builds, are also a step this way. These drills are based on actual errors. However, they are not yet tests,[33] although many could be so used. The testing movement requires more than even improved remedial drills.

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[32] White, W. T., *Typing for Accuracy* (H. M. Rowe Company, 1932).

[33] See also Ryan, M. S., "Analysis of Diagnostic Tests and Remedial Teaching in Typewriting Study," Master's Thesis (Cornell University, 1930).

It requires an actual test of your individual weakness, so that the drills can be based directly on its removal, and not on the mingled weaknesses of several thousand student typists. The diagnostic test comes first and sorts out whatever typing skills you already own. Time is never wasted on drilling what is already efficient. You drill to offset personal weaknesses or the common errors of your class. Errors made in common, too, are no less your own personal property. If all drills come first, much time is wasted in practicing, *perhaps disrupting*, abilities already adequate. If all drills come first, much personally needed practice is overlooked.

Today's diagnostic tests, in fact, are the superior modern substitute for the continuous drills of a day now past. The exercises typed are standard. This merely means that for each exercise its degree of difficulty has already been widely tried out and fitted to definite levels of typing improvements. Since there should be many of these typing samples, no one standard has to be fitted to all students.[34] You, for instance, may need drill at a very different level from that of your classmates. Numerous standard exercises thus present many different levels of difficulty. This practical material has been built up out of typing-class errors or of items that experts judge important or of high points from your manual; it has been further arranged until it is easy for you and other students to correct your work as you go along.[35] No sooner have you completed such a standard practice test than you can know to the dot how much and just where you fall short.

Literally, each diagnostic test is special practice material cleverly designed but cautiously put together. It is designed to reveal this and that special weakness in your typing. By way of illustration, perhaps you recall the clever design by which certain digraphs have been repeated regularly in simple sentences for your early keyboard mastery. This is the idea: If you should fumble that particular digraph, similar simple sentences would continue this repeated stimulation. Because a diagnostic test is designed to reveal a certain weakness, if you have it, you start its drill. The class takes this test material to discover common errors. You take this test material to discover your individual errors. These measurements seek to ferret out the special gaps in your studies. Each test should be arranged to make easier observation of any faulty attack on a typing difficulty — your hesitations, errors, erasures, thinking out loud.[36]

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[34] Carmichael, V. H., "Method of Grading Typewritten Work," *Fifth Yearbook* (Eastern Commercial Teachers' Association, 1932), Vol. II, pp. 164–175.

[35] Rollinson, E. A., "Fundamental Principles of Diagnostic Testing and Remedial Teaching," Monographs in Education, No. 12, *Research Studies in Commercial Education* (University of Iowa, 1932), Vol. V, pp. 4–14.

As the test is special practice material cleverly put together to bring out some special difficulty, it suggests the remedy. It suggests the *simpler level* at which the practice must now be applied. Wherever your test drill falls down, this identical practice material is simplified and expanded to furnish further conditioning against this difficulty. With a rising series of such diagnostic tests, you not only uncover your own weaknesses, but also are supplied with the kind of material needed to compete against your own scores. Particularly in your dealings with machine errors you can profit from a recent upward bound in this remedial work. Simplified lists of definite things to do have been built by Skene[37] and also by Rowe.[38] These supplement your technique check list. In fact, the latter suggests a regular schedule of corrective drills in throwing the carriage, adjusting paper or spacing, or stroking a tabular key. At present such lists for digraph errors, however, are somewhat vague and less valuable. All this is real thinking — the solving of personal problems along a measured path. These are tests of your actual learning. These diagnostic measurements, which should catch and clarify for you every difficulty, are already so long overdue in the typewriting field that at any moment the present trickle may turn into a flood.

[36] Jones, Vernon and Crook, Mason, "Educational Tests," *Psychological Bulletin* (1932), Vol. XXIX, p. 130.

[37] Skene, E. C., "Remedial Teaching of Typewriting," *Second Yearbook* (Commercial Education Association of New York City and Vicinity, 1932), pp. 73–80.

[38] Rowe, C. E., "Corrective Procedures for Wrong Typewriter Manipulation," *Fifth Yearbook* (Eastern Commercial Teachers' Association, 1932), pp. 176–185. Lists, pp. 180–181.

TYPEWRITING SAMPLES AS TESTS OF YOUR PROGRESS

1. *Distribution of student scores.* At first glance it may seem a very simple affair to measure typing ability by scoring actual samples. The number of words typed and the time plus the number of errors may seem definite enough. When a uniform typing sample is taken from students under such uniform conditions that comparisons are reasonable, the distribution of students' scores is an arbitrary but practical guide. It is practical, yet superficial, because it points to the inferior typist but lends no inkling as to what is inferior or why. For any of the various typing abilities, the scores of numerous students approach the usual curves of school subjects. This is apparent by a glance at the curves for spacing, capital-letter stroke, and carriage return of only 75 students from the Butsch study.[39]

For typing ability, accordingly, student scores may be conveniently distributed somewhat as follows: Very superior, the top 2%; superior, the next 8%; fast, 23%; average, the middle 34%; slow, 23%; inferior, 8%; very inferior, the bottom 2%. Superior and inferior ratings on standard samples thus become parts of the evidence by which the fit typist is separated from the unfit typist.

2. *Contest materials and rules.* All the important typewriter companies have furnished more or less free material for typing examinations. The only standard feature in much of this free copy is a key-stroke count. Illustrative of the best in such copy, however, are the International Typewriting Contest materials prepared by J. N. Kimball, long associated with speed-typing achievements. These present an impressive bulk of test copy carrying uniform averages in word strokes.[40]

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[39] See p. 226. For actual student scores during first and second years in Typewriting II, III, and IV, consult Carmichael, V. H., "Objective Measurement of Accomplishment in Typewriting of High-School Commercial Pupils in Indiana," and Malott, J. O., "Studies of Achievement in Shorthand, Typewriting, and Transcription," Monographs in Education, No. 12, *Research Studies in Commercial Education* (University of Iowa, 1932), Vol. V, pp. 125–135, and pp. 118–124. See also the footnote on p. 327 of this text.

[40] Similar tests are now privately published, such as Lessenberry, D. D., "Typewriting Tests" (Typewriting Test Publishers, Syracuse, New York).

Many sorts of arbitrary penalties have been assessed against errors in such typed copy. There is unfortunate precedent for this, as errors have been blandly ignored in many of the earlier typewriter "learning curves" dignified by print in technical journals. Many have been built out of words typed or gross strokes. Indeed, some of these "learning curves" would virtually disappear if errors were uniformly penalized. Even the experts do not agree as to just which errors are the more serious. Until this happens, it is safer to treat all repeated errors as reasonably serious. It is true that the seriousness of an error is mirrored somewhat in the later use made of the typescript. In this way Morrison[41] has started to simplify errors by having business men estimate to what degree an error leaves a letter mailable, or mailable only after correction, or unmailable:

Degree unmailable, 15, line omitted
Degree 10, uneven touch
Degree 8, word omitted, untidy erasures

Degree 6, word repeated, incorrect division of words
Degree 5, poor placement of the blocks of typing
Degree 4, transposed word
Degree 3, ghost letters, incorrect punctuation in body of letter, incorrect spacing between paragraphs, error in figures, proper name misspelled, plural for singular form, uneven left-hand margin

Degree 2, transposed letters in a word, misspelled word, letter not straight on page, uneven indenting of paragraphs, incorrect punctuation after a complimentary close, failure to capitalize a proper word, a letter slightly struck over, omission of a hyphen, capital letters not on the line, uneven right-hand margin

Degree 1, space omitted between words, incorrect spacing after punctuation, two spaces between words

Compare the latter mistakes in spacing with the first four errors and decide whether so striking a contrast in the degree of seriousness really exists between your own errors.

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[41] Morrison, N. B., "An Evaluation of Typewriting Errors," Monographs in Education, No. 12, *Research Studies in Commercial Education* (University of Iowa, 1932), Vol. V, pp. 153–157.

The International Typewriting Contests have popularized a useful though arbitrary step forward from the previous chaos. As a result, errors at present are usually penalized 10 words or 50 strokes. If you take 15 seconds to correct both an error and its carbon copy, this penalty is a fair offset when typing at 40 words per minute. For the usual single erasure and correction, however, this is a fair offset only when typing about 60 words a minute. If you cut this correction time down to 8 minutes,[42] then typing at 75 words a minute would bring a fair offset. But for any slower typing paces, obviously, the lower your rate, the more excessive is this penalty. The mere counting of 5 strokes as a word has helped more to simplify the measurement of typewriting. You will appreciate this further from your shorthand, since Nies[43] has found the strokes per 80 words varying from 197 to 279. While the counting of net words as 5 strokes each less 10 × 5 strokes per error has been a notable advance, yet further, less artificial simplifications are demanded and are close at hand.

3. *What a standard typewriting sample is.* Typewriting samples, perhaps the first of the workable *trade tests*, have long been widely used in employing typists. Yet the modern testing movement still shows a distinct lag in the typewriting field. Attempts to make test samples diagnostic in order to uncover error sources are usually vague. Standard test samples based on most common words and having definite levels of difficulty are few. Knowing this exact level of difficulty in a piece of standard copy is the high light in measuring. Just what is a typing-test sample of low difficulty, of medium difficulty, of high difficulty, and in what *degree* is this piece of copy "low," "medium," or "high"?[44] That so few satisfying uniform samples for measuring your typing have yet appeared is proof

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[42] Blackstone, E. G., "An Experiment in Erasing in Typewriting," Monographs in Education, No. 12, *Research Studies in Commercial Education* (University of Iowa, 1932), Vol. V, pp. 158–166. Also, Morrison, N. B., *op. cit.*, p. 156.

[43] Bureau of Public Personnel Administration, Washington, D. C., "Preliminary Work on Tests for Stenographers," *Public Personnel Studies*, Vol. 6 (1928).

[44] *Ibid.*

enough that such planning is far from easy. At present you run the risk of being tested with every variety of copy, from business letters to running reports. Scant attention is paid to the test wording, although it is well known that your success will be greater with more familiar words. Some examiners stress accuracy, with little or no penalty for slowness; others demand high speed. These are measurement nuts which must be cracked. The shells may be dented, but as yet few are broken.

4. *Office standards.* Measurement within your typewriting class should model itself on measurement within the modern business office, in order to safeguard your future transfer into such an office. If operators are left to busy themselves with this or that as the mood impels, the office output will be merely mediocre. If hourly standards are set for the tasks assigned, if the work is measured and incentive is added, office management engineers such as Leffingwell[45] expect abundant improvement. Thinking through problems in good management requires some extra effort in the way of measurement, which is richly compensated for. The measurement of your typing improvement requires a like extra effort, also compensated for by pleasing gains.

From friends in business you may have discovered that many offices seem to pay clerks for the courtesy of being present, since little effort is made to measure the typewritten output. Leffingwell[46] has set standards in one such department with fifteen operators. Some were writing 84%, 82%, 79% of the standard set, others only 22%, 25%, 39%, probably with about the same salaries. The usual output of typists is put by Leffingwell at less than 100 square inches each hour. This is readily doubled. If you are stimulated by surprising comparisons, George L. Hossfield's record is 864 square inches. Even though you are clicking off 30 to 50 words a minute in the classroom, this might drop to 15 words in the business office. Leffingwell[47] pictures few clerks as knowing even the right way to affix a postage stamp. By putting forth a great deal of energy, the usual clerk might affix 1000 stamps in an hour. By contrast, the easy motions of the trained worker affixing more than 5000 stamps in an hour appear slower.

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[45] Leffingwell, W. H., *Measuring Typewritten Work* (Veeder-Root, Incorporated), pp. 1–10.
[46] *Ibid.*

Naturally, your intensive guidance in the business office would start with minimum standards. Perhaps you enter the office of a manufacturing company where the transcribing standard is 1030 six-inch lines each day on a dictating-machine cylinder or on a transcribing-machine cylinder. Yet you find most of your qualified fellow workers producing 1400 to 1600 lines, the best, 2000 lines each day.[48] As soon as typewriting is measured by daily and weekly line or key-stroke counts, Leffingwell[49] looks for an immediate 10% or 15% increase in output. The lagging disappears. As assignments are made standard and incentives are added, he considers gains of 30% to 50% a not infrequent outcome.[50]

5. *Standard lines, inches, key strokes.* Since you already realize the value of counting your outputs, your use of a 5-stroke word or a similar unit might be swiftly overviewed.

(*a*) *Standard lines.* Previously you have examined bars that bring out a vivid, clear-cut picture of just what lines, accurate or inaccurate, are typed month by month. It is easy to count the number of lines by a line rule. This can be "homemade" to fit your machine if you type an empty sheet from top to bottom, 1, 2, 3 . . . once with single-spaced lines and once with double-spaced lines. As you read off this rule alongside your typed sheets, jot down the line length used. It is the widely different lengths of typed lines for which you have to allow while making this count. Of course, you wish to place each letter or block of typing on a page so that it appears well. For this artistic end, inevitably short letters are typed with short lines, long letters with longer lines. On the straight copy, however, a definite set of margin stops on the line scale holds down such purposely attractive variety. To use line units, such as the standard six-inch line, also affords you a pattern for attacking errors.

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[47] Leffingwell, W. H., "Training Clerical Workers on the Job," *Handbook of Business Administration*, W. J. Donald, Editor (McGraw-Hill Book Company, 1931), pp. 807–813.

[48] Farrell, A. C., "Measuring Office Output," *Office Executives' Series*, No. 32 (1928), p. 10.

[49] Leffingwell, W. H., *Measuring Typewritten Work*, *op. cit.*

[50] For readings about office routines, co-operative setting of standards by measurements, hourly work units at standard rates, study Leffingwell, W. H., *A Textbook of Office Management* (McGraw-Hill Book Company, 1932); Benge, E. J., *Cutting Clerical Costs* (McGraw-Hill Book Company, 1932).

(*b*) *Square inches*. If your lines are not the same length, you may find it easier to measure by the square inch, inasmuch as the latter really is a six-inch line. If your margins are already set for a 60-space line (or 72 spaces of the now popular elite type), then each full line is also one square inch of typing. Just estimate about how far short or beyond these six inches most of the lines seem to run. To measure your correspondence, lay a transparent scale over the body of the letter. Within six to twelve seconds the number of square inches can be read, with allowances. For date, address, salutation, and close you are allowed 2 square inches. For a double space between paragraphs you deduct 1 square inch; or if the entire letter is double spaced, deduct one half the reading. The final answer to this simple arithmetic approximates your actual output.

(*c*) *Key strokes, or five-stroke words*. This unit is quite precise when all strokes register on a cyclometer or similar counting device attached to your typewriter. This mechanical counter registers for some set number up to 240 strokes. Of course this voracious recorder is unreliable to the extent that you make poor and wasted strokes, since these are counted equally with efficient ones.

In all events, this count of key strokes, inches, or lines brings you clearly face to face with differences in assignments and results.

6. *Time-study standards for different assignments*. On certain assignments you might pile up as many strokes in ten minutes as you might do in an hour on other work, such as typing complicated tables consisting in large part of numerals. Letter writing from dictation, copying manuscript, report work, copy-

ing repeated forms, form-letter writing, long or short orders or invoices, statistical tables[51] — all require different standards.[52] The pace set for addressing envelopes, for example, might be 240 an hour; yet with a motion cycle of inserting large and awkward envelopes, reading addresses from very rough copy, typing unfamiliar addresses, and removing such envelopes, it might easily drop to 125 an hour. Furthermore, an office might have a more difficult type of business letter on which the standard might be only 150 square inches or 9000 key strokes an hour.[53] Standards, in fact, are individual for each office or classroom.

How can your classroom operate without a familiar stop watch so that you may take part in time studies that set and check such standards? Can you visualize each entire layout? With a stop watch can you time-study your transcribing steps, for instance, from the first selection of carbons, paper insertion, placing needle in position on the cylinder, adjusting headphones, on through the lines to be typed, to the final removal of paper and carbon removal, the checking off and the cleaning up?[54] Do you take full advantage of your own central control of the many Gilbreth variables in yourself, in your workroom, in your smooth succession of correct motions at faster paces?

7. *Standard survey tests.* The moment you become interested in such standards, you will appreciate how little is known about most test samples. How are you to measure yourself other than crudely when nobody knows just what your best practice materials measure? Prompter steps could be taken to standardize the best of present materials until the exact difficulty of each selection and the exact scores to be expected at each level of typing improvement have been definitely measured. State-wide tryouts of test material are illustrated by surveys in California (Kibby), Indiana (Carmichael), and Wisconsin (Clem). The

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[51] Compare with straight copy, for example, the exhibits of statistical assignments by Brown, E. H., *Statistical Typewriting* (Ronald Press Company, 1924).

[52] Leffingwell, W. H., *Measuring Typewritten Work*, *op. cit.*

[53] *Ibid.*

[54] Mitchell, John, "Measuring Office Output," *Handbook of Business Administration*, W. J. Donald, Editor (McGraw-Hill Book Company, 1931), pp. 904–918. For cutting stencils and duplicating, pp. 909–910.

Wisconsin commercial-education survey may be taken as a rather dramatic picture of just what such refinement means. Imagine available to every typewriting class in Wisconsin[55] uniform junior and senior test materials. Large and small, good, bad, and indifferent — almost every variety of typing class pools its scores with the central teachers' college. These scores are assorted until definite standards emerge at each student level in Wisconsin. Any young typist may then compare his performance exactly with that of all his fellow typing associates. He can actually measure the very improvement that he must make in order to reach or excel all or any proportion of his fellows. Any Wisconsin teacher now finds it a simple matter to gauge his class in terms of all similar typing classes in the state. Simplicity, to this extent, replaces confusion. The advantages of this system of norms based on a state-wide test are so apparent that several states have adopted this system for virtually all school subjects.

This junior typewriting examination[56] did offer (1) a stroking test, short but gauged to return at least 150 accurate strokes a minute on the "universal" keyboard by the end of the first year, (2) a test on the mechanics of the business letter, (3) a test on the placement of straight matter, (4) a new-type test, or objective test, to determine knowledge of the machine, points of form, and simple machine mechanics. This senior typewriting examination[57] advanced to (1) a more difficult stroking test gauged to return at least 250 accurate strokes a minute on the "universal" keyboard by the end of the second year, (2) the mechanics of the business letter with fewer directions, (3) simple tabulation work, and (4) a more formidable new-type test. The picture is even more complete now that Clem[58] has made these tests standard, hence usable in your classroom, too. Of course, the modern testing movement, as you know, now sweeps further than the essential survey tests.

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[55] Yoder, C. M., "Wisconsin Statewide Commercial Education Survey," *Balance Sheet* (1930), Vol. XI, pp. 229–232.

[56] *Ibid.*

[57] *Ibid.*

[58] Clem, J. E., "Standard Test for Measuring Stroking Rate in Typewriting," Master's Thesis (University of Chicago, 1931). Sample set (Public School Publishing Company, Bloomington, Illinois).

STANDARD TYPING SAMPLES AS TRADE TESTS

1. *An early attempt to hold conditions constant.* More than a decade ago a book was written around the National Business Ability tests.[59] Uniform tests were built in order to measure the simplest requirements of modern business: accuracy and speed in handling figures; correctness in spelling, punctuation, composing letters; remembering and following instructions in tabulating, invoicing, addressing, or filing. Within two parallel series were two fairly standard business letters to be either typed directly or transcribed after dictation at 100 words a minute. Working stenographers transcribed the 300-word letter at 40 words a minute with 7 to 8 errors; high-school graduates, at 30 words a minute with 15 errors. Tests were arranged also for duplicating machines. The stencils for either a damage-loss claim or a sales-report form, each 25 standard lines double spaced, were cut within a 15-minute limit. The modern tests, however, must hold more conditions constant.

2. *Thurstone and Hoke tests for typists.* In place of the usual business letter, the Thurstone [60] proficiency test for typists presents you with very rough copy, order writing, and spelling. Business managers increasingly prefer typists able to organize rather than merely to copy assignments. Perhaps to this end the score in the order-writing section is influenced by your ability to arrange the material in systematic order, whether in the original order, in order of dates, in order of amounts, in classes according to manner of shipment, or in alphabetical order by states. In an actual try-out on stenographers the Thurstone test rating has failed to measure success in the business office.[61] Only the Benge "Steno-gauge" returned distinct scores, such as 60 for all stenographers, 45 for those leaving their position, and 36 for those discharged. In

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[59] Cody, Sherwin, *Commercial Tests and How to Use Them* (World Book Company, 1920), pp. 153–154, 164–165.

[60] Thurstone, L. L., "Proficiency Tests for Typists," sample set (World Book Company, Yonkers-on-Hudson, New York).

[61] Bird, Norma, " Relationship between Experience Factors, Test Scores, and Efficiency," *Archives of Psychology* (Columbia University, 1931), Vol. XIX, No. 126.

like manner, Hoke's interesting test of stenographic ability and typing has failed to show any marked relationship to the success of 107 high-school typists.[62–64] Do you already suspect that these are not tests of your actual learning, but only of what you already have learned?[65] Yet your early office success depends in striking fashion on your ability to improve in special ways.[66] A rising series of practical diagnostic tests, accordingly, moves in this direction. A rising series of diagnostic tests built on your special practice materials supplies the measurements needed to compete against your own improvement scores. Obviously, tests on what you attempt to master give measures of your attainment.

3. *Blackstone typewriting examinations.* The Blackstone[67] typewriting examinations have blazed a path into the weakly charted region in which you are now traveling. All measurements are in strokes, discarding words, lines, square inches. A stroke is any "single movement in typing," so that four strokes would here be allotted to the first capital letter of a new paragraph (carriage throw, tabulator key, shift key, and letter stroke). The typing is timed to the dot of a second for three minutes. The marginal stops are set at 5 and 75, the tabular key at 10, the space regulator for double spacing. Even the typist is set — stroking *Dear* . . . at the flash of "Start." Nor is this set confused by a prior prod to hurry nor deepened by exciting competitive appeals to win.

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[62] Hull, C. L. and Limp, C. E., "The Differentiation of the Aptitude of an Individual by Means of Test Batteries," *Journal of Educational Psychology* (1925), Vol. XVI, pp. 73–88.

[63] Note also Kauzer, Adelaide M., *Typewriting Tests* (Bureau of Educational Measurements and Standards, Kansas State Teachers College, Emporia).

[64] See also Bills, M. A., "Method for the Selection of Comptometer Operators and Stenographers," *Journal of Applied Psychology* (1921), Vol. V, pp. 275–283, 373–379.

[65] Scudder, C. R. and Raubenheimer, A. S., "Are Standardized Mechanical Aptitude Tests Valid?" *Journal of Juvenile Research* (1930), Vol. XIV, pp. 120–123. This criticism is applied to the MacQuarrie, O'Rourke, and Stenquist tests for mechanical aptitude, after tests of 114 junior high-school boys. See also p. 288 of this text.

[66] With reference to this distinction between general ability and special learning, see also Atkinson, W. R., "The Relation of Intelligence and of Mechanical Speeds to the Various Stages of Intelligence," *Journal of Experimental Psychology* (1929), Vol. XII, pp. 89–112.

[67] Blackstone, E. G., "Blackstone Stenographic Proficiency Tests," sample set (World Book Company, Yonkers-on-Hudson, New York).

The examination is a business letter, with a corresponding average of 5.6 strokes per word. Each business letter is built with about the same number of words, most common digraphs, right-hand and left-hand motions, shift-key strokes and carriage returns, and with about the same positions for long or difficult words.

The scoring is worked out in vivid, concrete ways so that you actually see your results and not a mere abstract number score. Plotted on an individual progress chart, you see your freedom from errors climb as your speed moves from left to right across the chart. The arrangement is so excellent that no student can begrudge the extra time required to figure a test score that will fit the chart. The arithmetic used to compute this score is (*a*) multiplying number of strokes per minute by 10 and (*b*) dividing this by number of errors plus 10. Your class committee can quickly plot each score on the usual Otis percentile graph, and you can then see at a glance the range and variation of all scores in the typewriting class. Such percentile curves may rise one above another for a complete picture of your class progress. Perhaps the middle value of the 5-months' curve is then 88; of the 15-months' curve, 178; of the 25-months' curve, 220. Even the month is defined as four weeks of five recitations a week, each recitation as forty-five minutes. Each permanent record carries dates, months of instruction, strokes per minute, errors, and scores. In such a careful setup it is hardly necessary to add that the International Contest rules control the error counts. To the above extent Blackstone[68] has sought to keep conditions and therefore conditioning signals reasonably constant for you and all other students in the typewriting examinations.

STANDARD TRANSCRIBING FROM DICTATION

If you still fail to see why it is so hard to simplify these measurements, consider transcribing from dictation. You have the word of the Bureau of Public Personnel Administration[69] that no two transcribing tests even approach uniformity, owing to the extreme complexity of recording dictated material and later of translating the symbols into typewritten form.

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[68] Blackstone, E. G., "Blackstone Stenographic Proficiency Tests," sample set (World Book Company, Yonkers-on-Hudson, New York).

[69] Bureau of Public Personnel Administration, Washington, D. C., "Preliminary Work on Tests for Stenographers," *Public Personnel Studies* (1928), Vol. VI, pp. 46–55.

If you accept a sample checkup by this bureau, some excellent business offices are still unable to measure the work of their own stenographers. Consider this ridiculous result: In a sample of more than 50 stenographers, the better pay has seemed more often awarded to increased age rather than to either efficiency or experience. Between a stenographer's service efficiency rating and her actual scores or even her total errors on tests, the bureau has found little relation. Isn't this a shocking state of affairs for you to face when you graduate from school into a business office? You may be faster and more accurate, but your pay envelope may be sadly slim as compared with some conventional bluffer across the aisle who knows how to cover up a slower output. Does this bring home to you the surprising backwardness of most measurements in this confused field?

You will be interested in attempts of the bureau to simplify these measurements. An adequate test of transcribing ability will in itself measure typing ability. A series of letters was carefully written several years ago to test transcribing. Consider some of the complications:

1. *Rate of dictation.*[70] The usual office rate is considered not more than 100 words a minute. Speeding up the dictation to 110 words has had some effect in bringing out errors from weaker stenographers. Because of this fact, the dictation rates for these letters has been increased from 80 to 100 to 120 and 140 words a minute.

2. *Vocabulary.*[71] The probable ease of recording in shorthand, as viewed by the bureau's experts, accords fairly closely with the commonness of the words used. Saying it more or less roughly and generally, the more common a word, the easier it is to record it, regardless of its length, spelling, pronunciation, or even its shorthand strokes. The similar dominance of frequent sequences in typewriting has already been shown. Again using Horn's count of the most common words, these test letters run *as a scale* from letters

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[70] *Ibid.*

[71] *Ibid.*

written entirely with the most common 1000 words up to letters composed 70% of the 1000 most common words, 20% of the next most common 2000 words, 10% of the next 2000 words. Thus the least difficult business letter contains only everyday words, whereas less frequent words must be typed for nearly a third of the copy in a more difficult business letter. Actually the bureau has found that increasing this vocabulary difficulty fails to slow transcribing but does increase markedly and quite consistently the number of errors.

3. *Sentence length.*[72] Some business letters are built of short sentences, others of average sentences, still others of long sentences.

4. *Sentence complexity.*[73] To a degree the difficulty is lessened, according to the bureau's experts, if short, simple sentences are used. As the sentences become long and complicated, with phrases and clauses twisted out of their usual order, you can imagine how the difficulty jumps. Actually the bureau has noted that this change markedly and quite consistently increases the number of errors in the transcribing. Accordingly, some test letters are built of simple sentences, with words in natural order. Other test letters are built of complex sentences without inversions. Still other test letters are built of complex sentences with a good many inversions and somewhat unusual construction.

5. *Letter content.*[74] This bureau's experiments suggest that copy of practically the same vocabulary (for example, from the 1000 most-used words) and of the same sentence structure is easy when the content is familiar and difficult when it is not. Merely changing the content from a business topic to an unrelated topic, such as gardening or perhaps statistics, makes a great deal of difference. In tests of 185 typists, the bureau has seen that as the content of the letters becomes more complicated and less familiar, a somewhat longer time is needed for transcribing and the number of errors rises markedly. It follows then that some tests have to do with ordinary business matters. Other test letters tell of sales

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[72] Bureau of Public Personnel Administration, Washington, D. C., "Preliminary Work on Tests for Stenographers," *Public Personnel Studies* (1928), Vol. VI, pp. 46–55.

[73] *Ibid.*

[74] *Ibid.*

or promotion and are somewhat less familiar. The more difficult test letters are highly technical. Nor does it pay to be overfussy at this point in scoring errors beyond the misspelled, omitted, incorrect words and grossly incorrect punctuation. Indeed, a good operator of a dictating or transcribing machine may listen considerably ahead in order to edit, and perhaps considerably revise, the dictation as it is typed.

Perhaps you are already convinced that it is no simple matter to measure transcribing on a typewriter.[75] Remember, too, that there is little relationship between speed of transcribing[76] and typing from copy. Doubtless you are ready to review Barnhart's[77] brief and readable analysis as an immediate step further to simplify your transcribing.[78–79]

CASE STUDIES: THE SECRETARY-STENOGRAPHER

1. *Measurements of English usage, spelling, clerical and general ability.* As you measure your own typewriting against the background of other office work, bear in mind that clerical tests and even spelling have very little relation to typing skills. If you can follow scant correlation, with 1.00 as a perfect relationship, Stedman[80] brings you various comparisons from high-school typing students in Los Angeles. Obviously any relationship is slight. Blackstone typing-speed scores appear related to spelling results only .32 (with a probable error alone of .10). Surely you will not jump to the conclusion, however, that because typing skill and spelling are little related, the ability to spell is not important for your vocational

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[75] See also Kirk, J. G., "Selecting Standards for Shorthand Transcription," *Journal of Business Education* (1929), Vol. II, pp. 18–19.

[76] Hardt, G. J., "The Problem of Teaching Transcription," *Journal of Business Education* (1932), Vol. VIII, pp. 21–22.

[77] Barnhart, E. W., "An Analysis of the Work of a Stenographer," *Gregg Educational Monographs* (Gregg Publishing Company, 1927).

[78] See also Bibliography by Malott, J. O., "Teaching of Transcription" (Office of Education, United States Department of the Interior, 1931).

[79] See also Bibliography by Malott, J. O. and Segal, David, "Tests in Commercial Education, An Annotated List," *Circular* No. 56 (Office of Education, United States Department of the Interior, 1932).

[80] Stedman, M. B., "A Study of the Possibility of Prognosis of School Success in Typewriting," *Journal of Applied Psychology* (1929), Vol. XIII, pp. 505–515.

success. After studying dull youngsters with the aid of Detroit teachers, Baker is emphatic that dull pupils will make wretched stenographers on this count alone. Baker [81] estimates that a dull typist can probably spell only 500 to 1000 words correctly, even when typing from correct copy.

Use of good English, too, can be even more decisive. Stenographers differ more than you would possibly believe in just this use of plain English. The flow of words which you type should be as clear as though you were talking face to face with one who is to read the letter. Why practice personal typing unless at the same time you practice good English? Your typing studies are an English laboratory stripped clean to the essentials of usable words and fluent self-expression. By concentrating on these measurable high points in good English and spelling, O'Rourke [82] is able to lift as high as .73 the relations between his New Classification test for stenographer-typists and their office efficiency ratings. Naturally, these test ratings should differ widely when the assigned tasks also differ. Thus, O'Rourke [83] contrasts one group of stenographers who are to transcribe their notes exactly as given with a second group who are to compose letters and reports from their shorthand notes. For the former group, accuracy and speed in automatic transcribing are at least a third more important. For the latter group, ability to compose in correct English properly spelled, plus personality traits, such as initiative, ability to accept criticism, and tact, are two or three times more important. Here, likewise, standards are individual for each classroom task.[84]

Clerical examinations, such as the I. E. R. General Clerical test,[85] have much the nature of the so-called "intelligence" tests. Yet such mental abilities as arithmetic or bookkeeping relate only

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[81] Baker, H. J., *Characteristic Differences in Bright and Dull Pupils* (Public School Publishing Company, 1927), p. 49.

[82] O'Rourke, L. J., "Office Employment Tests," *Handbook of Business Administration*, W. J. Donald, Editor (McGraw-Hill Book Company, 1931), pp. 792–805.

[83] *Ibid.*

[84] See p. 445 of this text.

[85] Toops, H. A., *Tests for Vocational Guidance of Children 13 to 16*, Contributions to Education, No. 136 (Teachers College, Columbia University, 1923), pp. 133–134.

.39 to typing speed. Among these Los Angeles student typists, any relation with even Thurstone Clerical test results, surprisingly enough, is only .21, or distinctly lower.[86] Neglecting certain items, such as an alphabetizing test, helps somewhat. You may already have experienced this Thurstone Clerical examination on which you check for arithmetical errors, check for spelling, cancel and substitute symbols, arrange alphabetically names of cities, check insurance-policy dates in a table, solve arithmetic problems, and match proverbs.[87]

In this light, you would expect the similarly low relationships apparent when psychological examinations, even the rather simple Terman group-ability test,[88] are compared with Blackstone typewriting scores. An up-to-date reading test would be a more practical measurement. It is true that typing rates advance more quickly with more intelligent maturity. This growth, notably in muscular control, is very obvious in Owens's [89] survey of 4500 test samples at the close of a year in typewriting. The scores on the "universal" keyboard rise from 22 words a minute, typical of high-school freshmen, through 25 and 28 words to 30 words a minute, typical for seniors. Yet in general and regardless either of the "I.Q." or the grade, the paces improve the more typing is studied under motivating incentives.[90-91]

2. *Simplifying the secretary-stenographer role.* If you plan to use your typewriting in a career role as a stenographer or as a secretary, your measurements need wide extension. It has been conclusively demonstrated that the usual employment practice, with its naïve faith in a personal interview, is seldom reliable.

Perhaps the short path to a view of your own measured possibilities is a direct plunge into existing attempts to simplify the office field.

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[86] Stedman, *op. cit.*

[87] See also Tilford, G. R., "Prognostic Tests to Discover Secretarial Ability," *Contest Journal*, 1933 (Syracuse University).

[88] Stedman, *op. cit.*

[89] Owens, C. B., "Standards in Typewriting," *American Shorthand Teacher* (1930), Vol. XI, pp. 89–98.

[90] Wood, W. G., "Relation between Intelligence Quotient and Rate of Attainment in Typing," Master's Thesis (University of Southern California, 1928).

[91] Brewington, A. E., "Prognostic Tests for Typewriting," Master's Thesis, (University of Chicago, 1922).

The Bureau of Public Personnel Administration[92] has sought to simplify measurement of the secretary-stenographer role with ten items. The bureau's previous test for junior clerks contributes to these. If you should take this junior-clerk examination, for example, you would estimate yourself about as follows: If you score 194, you are exactly in the middle of the crowd of applicants for junior clerk — one half do better; one half do worse. The bureau further recommends that the employer eliminate the lowest 60%; therefore you must score at least 205. If you score 226 or over, you are in the best fourth of potential junior clerks. If you reach 260, you appear in the top 5% of superior junior clerks.[93]

Consider yourself, then, in the light of the following ten items:

(1) Can you handle oral directions?[94] You are given a 15-minute test. You listen to typical directions to a secretary-stenographer and write your answers to ten questions about them. You next listen to ten oral directions on checking certain items in a table, which you actually check. The bureau has tried out and partly standardized this test. Of course, it is essential that as a secretary-stenographer you catch spoken directions, whether or not under trying circumstances.

With this flying start, you are now ready for 65 minutes of self-giving tests to measure whether or not you know what secretarial work is all about. Within this time limit you should score at least 120 points even to be considered for the post. A score of 140 will place you in the top 30% of applicants. A score of 183 will put you among the upper tenth. Certainly to approach 225 would suggest that you are notably superior in this field.

(2) Are the facts about secretarial work at your finger tips?[95] Can you check 75 statements about these facts as either true or false?

(3) Can you understand and carry out written directions?[96] It is surprising how much others vary here. You follow ten written directions in actually checking a certain table. The bureau has fully standardized this test so that you compare yourself with others all along the line.

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[92] Bureau of Public Personnel Administration, Washington, D. C., *Public Personnel Studies* (1930), Vol. VIII, pp. 58–63.

[93] Bureau of Public Personnel Administration, Washington, D. C., *Public Personnel Studies* (1928), Vol. VI, p. 179.

[94] *Public Personnel Studies,* Vol. VIII, *op. cit.*

[95] *Ibid.*

[96] *Ibid.*

(4) Can you do errorless alphabetical filing?[97] In a list of 78 names arranged alphabetically you insert 40 new names. The bureau has fully standardized this test. Here, likewise, you compare yourself with others who vary a great deal in this single skill.

(5) Finally, how would you act were you the secretary-stenographer in person?[98] First, you read full descriptions of several situations and all attendant circumstances faced by a live secretary-stenographer. From 5 to 10 correct and incorrect ways of handling each situation are listed. You check the proper ways.

Does your score within this time limit reach 150 or perhaps even 221 points?

(6) How clever are you in handling contacts with other people, particularly the public?[99] For the next 30 minutes you imagine yourself making certain contacts. You size up each situation and check the best ways to get along with the people in them. This is a test of your social behavior.

(7) Do you use correct English?[100] You try to for 35 minutes. The bureau has fully standardized its test of this obvious essential for any secretary-stenographer. Does your English withstand this comparison with successful usage?

(8) Just how do your typewriting abilities fit into this secretary-stenographer framework?[101] Obviously such a person must do difficult stenographic work on occasion. For 45 minutes you transcribe after dictation (100 words a minute) and you also type from clear and rough copy. At the very least you should transcribe your notes at 25 words a minute.

(9) In addition to your successful scores in these practical tests, surely you will agree that a ten-minute summary of your education and experience is time well spent.[102] Will this show high-school graduation, perhaps more or less college work? Will this show one or more years of successful experience in a modern office organization?

(10) Finally, what general impression does your personality make in a short interview?[103] This friendly ordeal needs less than fifteen minutes. At the first you will be put at your ease and made to forget yourself. Shortly thereafter your natural conversation will bring out the following personal traits and lend a total effect to your agreeable personality:

(*a*) Are your speech and voice attractive?

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[97] *Ibid.*
[98] *Ibid.*
[99] *Ibid.*
[100] *Ibid.*
[101] *Ibid.*
[102] *Ibid.*
[103] *Ibid.*

(*b*) Do you dress attractively?
(*c*) Is your carriage erect?
(*d*) As the conversation shifts, are you quick to note the drift of questions and respond to them?
(*e*) If the discussion takes a controversial turn, can you still participate diplomatically yet effectively? Are you firm in taking a correct stand and willing to give up a stand shown to be incorrect?
(*f*) If posers and problems are put to you, do you find resourceful answers?
(*g*) Besides the above signs of tact and judgment, how does your general attitude toward life intrude? Do you give the impression of modesty or conceit, cheerfulness or gloom, maturity or immaturity?

You have just read a running account of a short case study of yourself as a future secretary-stenographer.[104] So many items enter into typewriting success or failure that a more detailed case study is often essential to a final estimate. This particular study would require somewhat over three hours of your time. As a case study, it is filled to the brim with practical measurements. Probably you will wish to emphasize these measurements. Why not treble your emphasis upon your scores in tests of practical secretarial skills (1–5)? Why not double your emphasis upon your typewriting scores (8)? Why not give half as much emphasis again to your correct English and social cleverness scores (6–7)? Why not leave the unreliable personal interview as it is?[105]

You have read this test series not as a model, but for a fuller picture of typewriting measurements in the future framework of a secretary-stenographer setting.[106–108] Naturally, you will want to be familiar with the more recent tests developed by O'Rourke and other experts.

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[104] *Public Personnel Studies*, Vol. VIII, *op. cit.*

[105] *Ibid.*

[106] See also Barnhart, E. W., "Secretarial Work in the Offices of a Large Oil Company," Monographs in Education, First Series, No. 11, *Research Studies in Commercial Education* (University of Iowa, 1929), Vol. IV, pp. 107–128.

[107] See also Doerschuk, Beatrice, "The Woman Secretary," *Proceedings* (National Association of Appointment Secretaries, 1928), pp. 11–17.

[108] See also Kyker, B. F., *The Commercial Curriculum* (Gregg Publishing Company, 1930).

Measurements check and double check the upward slope of your typewriting advance and gauge the closeness of your present fit in future typist, stenographer, secretarial frameworks. By the follow-through into vocational life, finally, measurements unvarnished by artificial credits decide the practical efficiency of each typing class. The school typewriter workroom is part and parcel of the huge educational "sieve" that sifts all students toward roles, high or low, in life. Final outcome is measured by your personal or vocational uses of typewriting in the everyday world.

FOLLOW-UP SURVEYS

1. *Regional follow-up contacts.* These outside fields are already penetrated to an extent by follow-up contacts like the survey[109] of nearly 3000 commercial students during their first decade after leaving Iowa high schools. What high lights are immediately evident? It is not enough to fit you to a position in the home community. There is ceaseless mobility wherein perhaps one half the young men and one fourth the girls whom you know are to leave the home town and seek paid work elsewhere. Many enter selling positions or climb to executive positions. Will you start your career as a salaried typist? Little more than one third of these Iowa girls enter typing, stenographic, or secretarial work. The proportions are 4%, 27%, 6%. Only 5% of these young men enter such positions. Holding more than one job, such as stenographer-clerk, is also somewhat more common for girls. Nor does stenography often lead to secretarial work; only 13% of these girl stenographers become secretaries. Even more leave to go to college. In fact, why will commercial students whom you know probably stay only a few months in each job or leave business pursuits altogether? Have you an answer that fits your own future?

2. *Local, personal follow-up contacts.* Even more than the state-wide survey does the personal follow-through by a local college or high school safeguard this transfer to typing usage in offices

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[109] Blackstone, E. G., "Survey of Occupational Histories of Iowa Commercial Students," Monographs in Education, *Research Studies in Commercial Education,* First Series (University of Iowa, 1929), Vol. III, No. 9.

and stores. Battin High School of Elizabeth, New Jersey, actually checks to find 81 of 89 graduates using the typewriter in their first positions.[110] What new facts come to light when Latrole High School keeps in touch even with its commercial dropouts for three years? Of 33 who were graduated into the business field, only 5 were stenographers and only 2 typists. You are then reminded that hardly a tenth of office workers are stenographers.[111] Most frequent among 39 office activities in Latrole are: (1) telephoning, by 21 former typing students; (2) filing and indexing, by 18 former students; (3) correspondence, typed by 18; (4–8) checking and verifying, adding-machine and listing-machine operating, inventory taking, handling mail, cashier work, each by 15 former students; (9–10) taking dictation, selling, each by 14; (11) typing from copy, by 13; (12–13) typing bills, cost figuring, each by 11 former students. While no gaps appear in preparation for the typewriter, this high school discovers an unanticipated assortment of other office skills that ought to accompany general use of typewriting in business.[112]

CASE STUDIES AND CO-ORDINATORS

1. *Educative part-time experiences.* Do you plan to be a vocational typist? Then how short of all-inclusive office training have you fallen? Few schools, even with distinct stenography, bookkeeping, merchandising, and general clerical majors, train for more than one tenth or one fifth of the shifting duties in commercial positions.[113] Most commercial departments completely overlook the possibility of your co-operative employment, alternating one week in office or store, one week at school. Yet part time in employment and part time at school offer the outstanding incentive and the liveliest kind of practice for the transfer into workaday

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[110] Butts, F. M., "Research Material in Typewriting," *First Yearbook* (Eastern Commercial Teachers' Association, 1928), p. 180.

[111] Hoover, E. C., "Occupations Most Frequently Filled by Drop-outs and Graduates," *Balance Sheet* (1930), Vol. XI, pp. 272–279.

[112] See also Wright, B. H., "A Follow-up Study of Stenographers and Office Workers," *Vocational Guidance Bulletin* (Minneapolis Public Schools, 1930), Vol. IV, pp. 2–4.

[113] Kyker, B. F., "Evaluating Business Education by Business," *Proceedings* (National Education Association, 1930), Vol. LXVIII, pp. 283–285.

life. What if your typing class seems responsible for but few among several dozen future office duties?[114] Have student days fully sharpened your experiences in transcribing, in editing dictation, in telegraph service, even in teletypewriter service, in long carriage tabulating, or in duplicating? Few commercial departments yet act on the admitted fact that experience is won in business offices and stores. Few schools yet move to protect this transfer. Certainly to provide these adequate experiences in the schools is, as Finney[115] puts it, an utter impossibility. In your interest and in the interests of American society as a whole, schoolmen can neither ignore nor side-step forever the incisive issue thus thrust by Finney[116] into a single query, "Who is to control these educative experiences, the educator or the employer?" Faced with the sweeping advances of American business and industry, educators must needs strive to surmount this current educational lag.

2. *Rise of commercial co-ordinators.* The rising role of school co-ordinators who will protect and supervise this vital vocational transfer looms as a great educational event of the future. Their guidance would draw on practical measurements not only of typewriting but also of individual student typists in live social settings. If a co-ordinator and an employer were already co-operating to make your transition into paid work less awkward and more educative, this new extramural schooling would contribute to your applied typing skills and better personality.[117] Relatively few public high schools or junior colleges hitherto have taken the first steps of surveying systematically the possibilities for your generation's placement in even the surrounding city or of examining these future office or store positions in detail.[118]

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[114] Ely, M. H., "Will a Practical Office Training Department Ever Be Developed?" *Proceedings* (National Education Association, 1930), Vol. LXVIII, pp. 285–288.

[115] Finney, R. L., *A Sociological Philosophy of Education* (The Macmillan Company, 1929), p. 252.

[116] *Ibid.*

[117] See Brewer, J. M., *Cases in the Administration of Guidance* (McGraw-Hill Book Company, 1929), pp. 135–137, 139–144, 153–161, 163–164, 169–175, 199–200, 231–232, 253–255, 276–279.

[118] See, as an instance of guidance control, Coleman, Evans, "Co-operative Education in College," *Journal of Business Education* (1932), Vol. VII, pp. 14, 16.

3. *Case studies of typists in special fields.* Follow-up surveys break ground for future careful case studies of successful typists in distinct fields. These measurements will simplify in usable detail the definite jobs and the actual difficulties and personalities of the retail typist, the financial typist, and the operators in transportation, in important industries, and in the varied professions. Each of the great vocational fields will be defined by case studies of successful typists therein. Upon some such case study should be based the standard forms and workbook for your advanced typing, with corresponding measurements to estimate your fitness. The overburden of standard practice forms, amounting to two thirds of your usual typing material,[119] which now detracts from the full conditioning of your stroking, timing, and pace, will be thereby lightened. In advanced typewriting, however, rising speeds from measured practice on straight copy will merely parallel your increasing fitness for specialized, office-typing jobs. Such case studies and measurements would also open definite new worlds to you in a variety of possible roles as retail, financial, or industrial typist, as an operator in transportation or communication services, or typing in the professions. New and civilized attitudes would reflect these new occupational worlds.

INTERPRETATIVE SUMMARY

Those final outcomes which are to control and unify the entire typewriting course are simplified by measurements. The goals thus defined range from the simpler outcomes for personal use and any advances for general business typing to the specialized outputs required of typing services in business or industrial or professional employment. Without this simplification by well-developed measurements, the typing classroom presents a confused, even chaotic field.

Classroom vocational typing should match actual findings from each survey of placement opportunities and from each job analysis of actual office motions. The advent of careful case studies of successful typists in distinct fields, such as retail, financial, or industrial typing, in transportation or communication services, or typing in professions, helps prepare an outgoing student to face many social and technical demands. The better to safeguard this transfer to a vocation, however, school co-ordinators and employers should co-operate to furnish part-time employment experiences. No typing classroom can possibly approach this complete experience or render the transition into paid work so much more educative and less awkward. Final outcomes are measured with regional and local follow-up surveys. Such final checks rather than artificial school marks discover typing-classroom efficiency.

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[119] Debra, F., "An Analytic Study of Present Methods of Teaching Typewriting," Monographs in Education, First Series, No. 9, *Research Studies in Commercial Education* (University of Iowa, 1928), Vol. III, p. 123.

In up-to-date office practice minimum hourly standards, whether in standard lines or square inches or stroke counts, are set for each different assignment, and incentives thereto are provided. Individual classroom standards based on motion and distance-time studies should set up improved layouts and typing cycles from start to finish.

Each attempt to simplify the secretary-stenographer role demonstrates the superiority of measurements over any unreliable personal interview. Tests of general ability, spelling ability, and clerical abilities have scant relation to typing levels, yet these do help picture the frame of a secretary-stenographer setting.

Each attempt to simplify transcribing by measuring standard samples helps reduce the present chaos of complicated variables. Uniform typing samples as trade tests demand repeated tryouts, until the degree of difficulty of each sample is definitely known. The Blackstone business-letter tests demonstrate this use of standard typing samples to fix the definite level of a typist's performance. State-wide tryouts of typing-test samples bring out clear-cut standards for rising student levels. Any student or class performance can then be gauged in terms of the regional achievement of all others. Simplicity to this extent replaces confusion. As compared with actual typing motions, tests of tapping or other motor ability fail to select the bulk of successful typists. Planning and carrying out personal typing improvement is more a matter of central control over spatial, mechanical, and copy relations and less of finger dexterity. While standard samples check on actual stroking, shifting, tabulating, centering, and carriage returns, further insights into technique are rapidly tested by building and using new-type objective examinations.

Increasingly, the newer straight-copy drills are based on wide surveys of mixed errors. Diagnostic tests, however, should come first in order that practice can be directed as existing individual weakness. Today's diagnostic-test material is cleverly designed to reveal this or that special flaw if present. This simplifies the observation of any student hesitations, errors, erasures, or thinking out loud. This material is widely tried out until its level of difficulty is known. Its typing then brings out any weakness in a student's attack on whatever difficulty has been so carefully placed in the exercise itself. If this occurs, at once the material is expanded into similar materials at a simpler level for the student's practice. A rising series of diagnostic practice materials would enable each student to compete adequately against his own scores. Here is wide room for teaching initiative. The available typing tests are not yet designed to bring out thus deliberately a definite, known difficulty or to point to remedial material. As present tests merely measure net scores at which a student already typewrites, diagnostic measurements that catch and clarify learning troubles and their remedies are long overdue.

Student diaries contribute such a lucid picture of student attitudes that in comparison the official class measurements seem small and lifeless. Only when a student clearly has a correct attitude can he be launched on self-directed practice. A student's folder carries not only his more important typing papers, but also, as personal stocktaking, these diary comments on how he feels about measured results of his practice and about concrete typing troubles. An occasional class hour brings these individual difficulties to conference. This teaching by class conference should elevate academic standing of typing studies until these embrace a course in applied science of motion and time study.

Desirable attitudes rather than fixed habits are the continuing goal of each typing class. Correct attitudes control all successful typewriting behavior. The very tension in typing muscles varies with whatever attitude is adopted. As time marches, the measurement of attitudes commences to emerge from past intangible vagueness. Mostly attitude is a matter of feeling rather than of memorizing set details. Measurement of typing attitudes must fit individuals and remain flexible, even as the typing remains flexible. The parade of personality check lists, with which the first part of this typewriting study commenced, is still inadequate. Any such systematic checkup of the whole typist needs the immediate stimulation of his attitudes in action. The new self-study practice tests move in this direction. When available check lists of personality assets and liabilities as a typist, plus standard samples of typewriting, plus best examples drawn from original typing practice and diary comments thereon are collected into a cumulative personnel record of each student typist, a new insight into his further typing career becomes possible.

If the complete folder concerning each student is matched against case studies of successful typists, and if these studies actually reveal the work units and personality assets needed in each distinct field of typewriting, then the choice of vocational typing comes face to face with reality. This outlining of measurements possible in the future implies the wasteful, often harmful gaps in a present policy of drift into unsuited and substandard work.

By helping the student typist to self-discovery of correct typing attitudes, measurements help also to build these attitudes. In their light the typist can approach future typing with added confidence. He feels confident that the future is to have a social setting wherein he can achieve the necessary balance. This happy, balanced state is popularly acclaimed as success. The student's typewriting is closely fitted into a new setting of business or industry or social life — intrinsic parts of American culture. The valued uniqueness of this final outcome lies not in the typewriter for its own sake, but in its use through greatly improved written outputs, to express oneself and the allied projects of others, as part of this American culture.

APPENDIX

THE ONE HUNDRED "TYPEWRITING DEMONS" ON THE "UNIVERSAL" KEYBOARD[1] AND ON THE "SIMPLIFIED" KEYBOARD[2]

"Universal" Keyboard

1 the
2 to
3 of
4 and
5 is
6 which
7 it
8 that
9 when
10 for
11 with
12 have
13 be
14 would
15 will
16 work
17 you
18 but
19 thank
20 in
21 this
22 are
23 was
24 their
25 do
26 good
27 time
28 write
29 there
30 never
31 they
32 my
33 we
34 your
35 what
36 very
37 been
38 his
39 thing
40 them
41 he
42 like
43 has
44 turn
45 as
46 those
47 think
48 more
49 can
50 some
51 great
52 must
53 should
54 could
55 effort
56 than
57 take
58 if
59 every
60 give
61 well
62 only
63 then
64 one
65 not
66 done
67 these
68 about
69 word
70 ever
71 say
72 began
73 begin
74 people
75 away
76 other
77 day
78 over
79 up
80 from
81 look
82 find
83 our
84 by
85 doubt
86 because
87 many
88 year
89 two
90 so
91 told
92 heart
93 eight
94 same
95 while
96 also
97 most
98 said
99 had
100 I

"Simplified" Keyboard

1 new
2 beautiful
3 during
4 everything
5 help
6 oblige
7 certain
8 company
9 length
10 October
11 possible
12 result
13 serve
14 stamp
15 never
16 importance
17 awful
18 committee
19 close
20 difference
21 however
22 most
23 November
24 obtain
25 suggest
26 their
27 tonight
28 various
29 vacation
30 work
31 office
32 principle
33 accept
34 addition
35 arrangement
36 behind
37 build
38 change
39 condition
40 card
41 desire
42 enclose
43 enjoy
44 family
45 marriage
46 husband
47 half
48 hold
49 itself
50 impossible
51 January
52 kind
53 leave
54 loss
55 March
56 opinion
57 probably
58 pleasure
59 particular
60 request
61 rate
62 rule
63 south
64 subject
65 service
66 song
67 though
68 therefore
69 watch
70 name
71 high
72 where
73 home
74 baby
75 whose
76 just
77 life
78 public
79 table
80 under
81 women
82 action
83 anyway
84 always
85 article
86 against
87 anything
88 alone
89 become
90 blue
91 begin
92 black
93 charge
94 children
95 character
96 conference
97 consider
98 copy
99 class
100 cause

NOTE. An examination of the two lists of words discloses that whereas on the "universal" keyboard the words most often mistyped are frequently occurring simple words, on the "simplified" keyboard the words most frequently mistyped are the longer, more difficult words.

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[1] Dvorak, A. and Ford, G. C., "Typewriting Demons," *Journal of Business Education,* May, 1932.

[2] Davis, D. W., "An Evaluation of the 'Simplified' Typewriter Keyboard," *Journal of Business Education,* May, June, September, and October, 1935.

LETTER-ERROR CHART FOR THE "SIMPLIFIED" KEYBOARD[3]

Read across the page, thus: A was struck for B 4 times; for C, 0 times; for E, 32 times, etc.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
A was struck for		4	—	3	32	—	1	9	26	—	—	3	3	4	217	1	—	5	12	5	2	2	1	—	1	—
B was struck for	3		1	18	2	1	—	—	—	—	3	—	23	4	2	1	—	—	—	—	1	—	1	—	1	—
C was struck for	1	—		1	5	—	12	1	2	—	—	1	—	1	—	—	—	18	2	34	—	—	1	—	—	—
D was struck for	2	19	—		1	8	3	22	18	—	—	1	—	1	1	—	—	1	3	5	1	—	—	1	2	—
E was struck for	18	1	3	3		1	—	10	27	—	—	3	—	2	153	—	1	6	5	23	26	2	1	—	3	—
F was struck for	—	—	—	9	2		26	—	3	—	—	1	—	—	1	—	—	1	—	—	—	1	—	—	19	—
G was struck for	—	—	11	1	—	61		6	—	—	—	—	1	2	—	17	—	—	—	—	2	—	—	—	4	—
H was struck for	3	4	1	50	10	5	—		1	—	1	—	26	6	2	1	—	—	3	47	12	—	—	1	—	—
I was struck for	12	—	—	18	25	1	1	5		—	1	3	—	11	12	1	—	8	7	9	35	—	—	1	3	—
J was struck for	1	—	1	—	2	—	—	—	—		6	—	—	—	—	1	1	1	1	—	1	—	—	1	—	—
K was struck for	—	4	—	—	—	—	—	—	2	1		—	—	1	—	—	—	—	—	—	1	1	—	13	—	—
L was struck for	—	1	1	2	7	3	—	1	2	—	—		—	2	—	13	—	24	41	2	1	—	—	—	—	—
M was struck for	1	50	—	1	—	—	1	17	1	—	2	—		2	1	1	—	—	2	3	1	7	21	—	—	—
N was struck for	—	—	3	6	1	—	1	6	10	—	—	2	7		17	—	—	57	40	50	1	16	2	—	—	—
O was struck for	134	2	1	4	167	5	1	1	14	1	—	5	3	12		1	—	13	17	6	15	—	4	—	5	—
P was struck for	—	3	—	1	2	3	17	—	1	—	—	1	—	—	3		—	14	—	1	13	—	—	—	34	—
Q was struck for	1	—	—	—	1	—	2	—	—	1	—	—	—	—	5	—		—	—	—	—	—	—	—	—	—
R was struck for	4	—	27	—	7	2	—	—	8	—	—	31	—	60	15	3	1		1	9	2	5	—	—	4	—
S was struck for	5	—	3	6	7	—	—	5	3	1	—	50	3	46	5	—	—	10		12	—	—	1	—	—	1
T was struck for	1	—	38	15	42	6	—	44	7	—	2	—	—	46	9	—	—	4	9		5	—	22	—	3	—
U was struck for	10	1	—	—	56	2	—	2	50	—	—	2	—	5	7	4	—	3	1	3		—	2	—	1	—
V was struck for	1	1	1	—	—	—	—	—	—	—	—	—	—	44	—	—	—	1	10	—	—		10	2	—	1
W was struck for	—	—	6	—	2	1	—	—	—	2	—	—	22	4	4	—	—	—	—	19	—	12		—	1	—
X was struck for	—	8	—	—	—	—	—	—	3	—	11	—	—	—	—	—	—	—	—	—	—	1	1		—	—
Y was struck for	2	—	—	—	3	19	4	—	9	—	—	—	2	—	1	37	—	2	—	3	1	—	—	—		—
Z was struck for	2	—	—	1	—	—	—	—	6	1	—	—	—	—	—	—	—	—	4	—	—	—	—	—	—	

NOTE. A comparison of this letter-error chart with the one on page 505 indicates that whereas Dr. Lessenberry found 648 out of 650 of the possible letter substitutions in the "universal" keyboard material, Davis found only 325 possible letter-substitution errors in his examination of material typed on the "simplified" keyboard.

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[3] Davis, D. W., "An Evaluation of the 'Simplified' Typewriter Keyboard," *Journal of Business Education*, May, June, September, and October, 1935.

LETTER-ERROR CHART FOR THE "UNIVERSAL" KEYBOARD[4]

Read across the page, thus: A was struck for B 69 times; for C, 106 times; for E, 560 times, etc.

Prepared by D. D. Lessenberry, Head of Department of Commercial Education, School of Education, University of Pittsburgh, Pittsburgh, Pa.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
A was struck for		69	106	71	560	102	24	139	148	26	15	136	58	61	126	60	89	104	1012	116	46	96	100	33	46	139
B was struck for	36		37	43	33	44	163	42	12	8	3	25	57	262	43	13	1	7	28	40	21	773	7	6	15	9
C was struck for	59	43		486	98	67	22	19	36	7	27	14	20	84	25	1	7	30	174	28	14	466	22	133	8	9
D was struck for	65	43	436		755	394	117	23	73	27	484	58	7	80	27	6	2	72	862	119	22	21	30	22	11	1
E was struck for	494	28	149	651		72	76	114	1019	20	25	141	66	75	174	27	5	813	276	273	95	44	638	17	77	7
F was struck for	43	80	92	524	72		586	56	66	176	24	38	6	27	56	47	3	419	71	153	12	159	12	1	8	1
G was struck for	35	241	34	166	75	541		461	24	54	41	17	9	59	8	5	8	37	30	267	18	51	9	3	8	3
H was struck for	40	44	43	22	42	47	389		100	207	111	21	19	275	46	15	6	26	36	117	44	11	9	4	99	1
I was struck for	159	10	17	73	907	28	25	84		30	211	81	50	90	915	21	13	59	78	160	560	54	20	2	27	1
J was struck for	11	6	10	11	21	140	62	489	46		217	49	242	188	28	7	1	6	4	40	128	5	1	2	10	2
K was struck for	17	10	34	287	29	11	16	66	172	101		521	37	44	56	10	2	17	23	16	7	2	2	4	3	—
L was struck for	119	44	16	59	116	54	24	42	106	54	413		62	97	567	92	7	40	150	77	29	3	8	7	14	3
M was struck for	52	16	11	8	41	6	15	13	27	60	56	21		1577	77	24	5	17	25	14	36	39	6	3	2	2
N was struck for	93	135	33	44	87	19	68	151	90	28	17	50	1249		68	10	6	27	74	67	25	63	8	6	22	3
O was struck for	210	18	23	30	134	82	20	68	1290	26	52	671	54	63		346	36	154	78	112	154	22	104	8	22	3
P was struck for	33	11	9	6	56	11	10	14	28	3	6	46	15	24	405		36	23	14	43	19	6	13	3	15	1
Q was struck for	232	6	5	3	21	11	12	7	9	3	—	4	10	3	10	22		6	16	66	20	17	109	3	6	6
R was struck for	111	15	40	139	1043	334	36	24	92	5	7	27	14	70	140	33	8		186	1488	398	58	67	19	28	7
S was struck for	954	23	260	1061	300	106	23	16	69	6	24	162	27	91	68	12	8	156		150	57	59	410	157	15	19
T was struck for	97	38	24	105	212	185	254	129	157	26	20	65	15	58	79	23	55	1407	168		58	7	55	45	327	5
U was struck for	33	59	10	28	64	17	15	49	519	124	23	40	13	35	123	21	40	217	81	99		22	25	52	419	12
V was struck for	45	1001	430	39	71	137	38	28	35	1	2	10	34	101	17	2	18	44	24	11	40		11	11	20	1
W was struck for	89	9	10	76	927	26	6	19	15	3	1	17	16	22	122	30	96	136	382	95	18	26		10	12	26
X was struck for	33	12	292	35	24	1	3	11	8	5	1	2	9	8	11	5	5	21	225	23	23	10	12		16	191
Y was struck for	44	10	5	18	57	11	26	109	33	13	3	12	18	31	12	11	5	32	138	508	502	90	43	13		8
Z was struck for	288	7	6	7	6	2	3	2	10	1	3	3	1	5	4	4	6	13	34	6	2	9	30	108	6	

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[4] Lessenberry, D. D., *Error Chart* (L. C. Smith and Corona Typewriters, Inc., Syracuse, New York).

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