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Miles Albert Tinker and the Zone of Optimal Typography

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Miles Albert Tinker

and the

Zone of Optimal Typography

by

Sandra Wright Sutherland

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Abstract

Miles Albert Tinker and the Zone of Optimal Typography

by Sandra Wright Sutherland

Chairperson of the Supervisory Committee: Professor William D. Winn
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For thirty-two years Miles Albert Tinker conducted basic research on the interaction between typographical conditions and the reading process, resulting in a body of scientific data which offers guidelines for producers of instructional materials, especially print. Tinker studied typography, eye movements, illumination, ergonomics, standard psychology, and reading. Confusion between reading and typography as imagery caused misunderstanding of Tinker's basic research.

Objectives of this dissertation were:

1) to present evidence that Tinker was a well-trained experimental psychologist who worked within the mainstream of psychology while conducting specialized research,

2) to show how Tinker's methods developed,

3) to demonstrate, with the aid of graphic arts literature, why Tinker's work did not significantly impact that area,

4) to propose a structural framework, the Zone of Optimal Typography (ZOT), within which Tinker's work might be organized,

5) to document a complete record of Tinker's articles, books and book reviews,

6) to visually demonstrate Tinker's results within the body of this dissertation and its appendices, and finally,

7) to produce the dissertation with state-of-the-art technological innovations not available in Tinker's time, but to which the discussion based on his work may apply.

Historical research holds significant contributions for today's technologies and for understanding of modern developments in research and theory.

In presenting this dissertation in partial fufillment of the requirements for the Doctoral degree at the University of Washington, I agree that the library shall make its copies freely available for inspection. I further agree that extensive copying of this dissertation is allowable only for scholarly purposes, consistent with "fair use" as prescribed in the U. S. Copyright Law. Requests for copying or reproduction of this dossertation may be referred to University Microfilms, 300 North Zeeb Road, Ann Arbor, Michigan 48106, to whom the author has granted "the right to reproduce and sell (a) copies of the manuscropt in microform and/or (b) printed copies of the manuscript made from microform."

Signature Sandra Wright Sutherland

Date 2-27-89

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Preface

The significance of typographical factors was made clear to me by hearing impaired high school students whom I taught for thirteen years (1972 - 1985) in Escondido Union High School District (EUHSD), Escondido, California. Their negative and positive responses to educational materials seemed as much related to typography as to subject matter or pictures.

The significance of book appearance is a familiar issue to special education teachers. The search for low language level materials for special education students often results in 1) use of materials prepared for lower grade levels (with large print) or 2) adaptation of materials prepared for regular class students (with high text density). High school students are particularly sensitive to the appearance of these resources. To them, large print means "baby book" and small print brings agony-filled anticipation of difficult materials.

Deaf students become frustrated by dependence on "baby books" and materials they don't understand. Avoiding frustration becomes an increasingly hard-fought battle. When lack of desire to learn becomes a mask for inability to deal with educational alternatives, the caring teacher seeks solutions.

Fortunately, I was able to custom design the Hearing Impaired Program for my students. As part of the program design, students were offered vocational training, especially in the district/ ROP print shop, run by Gary Miller, and classes in photography (Gary Sadnick), which allowed me to assist, utilizing my own art background. I also interpreted, using sign language, for students taking these classes when needed, especially early in their placement.

During summers I enrolled in classes at Palomar Community College, San Marcos, California, in Neil Bruington's Graphic Communication program. In 1981 I took a year's sabbatical leave to take classes at Palomar full time in graphic arts and photography. Aside from learning skills, I also learned more about this vocational training facility which was the closest post-secondary training facility for my students, whether pre-vocational or pre-higher education. As the years went by I saw few of my students going to four-year colleges, reinforcing the importance of vocational training, regardless of post-secondary plans. Bruington proved sympathetic to my work

and patiently helped me and students graduating from EUHSD who wished to continue their training in Graphic Communication.

At Palomar, I learned of the many decisions made by printers and designers, including typographers, in the production of print materials. Discussion of legibility, typography, and layout design decisions remained on my mind when I returned to my job in Escondido, now surveying educational materials from a new perspective.

My teaching philosophy from the beginning of work in this mainstream program had been that hearing impaired students would profit most by receiving instruction from specialists, with support from resource personnel (including myself). Teachers within academic specialties (history, English, science, etc.) both possessed and used a wide variety of resource materials that I could not hope to provide. I also wanted hearing impaired students to begin true integration into society's mainstream, partly because the time for such integration was fast approaching and partly because the time for their primary skills development was past. Students were therefore integrated into as many classes as possible with kind cooperation from selected teachers who accepted and assisted handicapped students with open hearts.

As a result, I found myself conducting a considerable amount of organizational planning and tutoring students in virtually all regular classroom subjects, generally using materials from those classes. I was in a position to survey materials chosen by the district for use in three high schools, grades 9 to 12. I was also able to survey materials prepared by teachers for use within various specialites.

Materials chosen by the district were, I supposed, judged primarily on content, because some of them were visually tedious. One example was a thick and heavy text with small print and out-of-date pictures which was being used in a ninth grade social studies class. My student in that class was hyperactive, in addition to hearing impaired, and this book held no attraction for him whatsoever, and made my work much more difficult.

While some of the teacher-made materials given to my students were excellent, some of them, especially those produced on the standard ditto machine, were marginally legible. One hand-out I received was quite illegible, and I wondered how the teacher of that class could have imagined any student completing that illegible assignment, much less a severely hearing impaired tenth grader with

poor language skills. Illegibility is a problem for regular class students, but a disaster for special education students.

Aside from my own students, other students were receiving these materials, some with vision problems, some with learning disabilities, etc. Since the teachers involved were intelligent, caring people, I could only reason that handing out marginally legible materials resulted from simply underestimating the importance of materials presentation, especially coupled with considerations of visual cognition in readers. I knew that training on this issue was unlikely to have been included in education methods classes. I began to see my mission.

I had taken classes at San Diego State University in Educational Technology, but that institution offered no doctoral program. Upon investigation I found that such a program existed at the University of Washington, my parents' alma mater.

On December 16, 1983 I wrote to several UW professors seeking information on psychological effects of typography in the reading process. From Dr. Timothy Standal I received a note, "This is probably Tinker's work," and from Dr. Patricia Nolen, a reference to one of Tinker's books. I acquired Bases for Effective Reading (1965) and Legibility of Print (1963), the latter a summary of Tinker's life's work investigating typography. I realized that my interest was a valid research issue and that a body of work already existed in this area. Beginning my work in Educational Psychology where I felt this inquiry belonged, I was soon steered toward Educational Communication and Technology and Professors William D. Winn and Stephen T. Kerr.

I did not know that the University of Washington was in the process of revising the Educational Communication and Technology program in precisely the direction of my foremost interest, research and theory. Since beginning the Ph. D. program at the University of Washington in 1985, I have had the good fortune to work with Professors Winn and Kerr who have expanded my awareness of theory and application to areas associated with my primary focus of inquiry, including cognitive processing of charts and diagrams and design of computer screens.

I discovered that Tinker's basic research has been largely forgotten over the years with the exception of his 1963 summary work. Research trends seen in Educational Communication and Technology Journal, (ECTJ) from 1984 through 1988 indicate that the

time may have come for use of this work by a population newly empowered with design decisions through modern technological innovations which were not previously available. In 1986 articles began appearing in ECTJ, notably Morrison's 1986 "Communicability of the emotional connotation of type". This was followed soon after by Hartley's (1987) "Designing electronic text: The role of print-based research" and Morrison's (1988) "Text density level as a design varable in instructional displays." While it has been tempting to begin relating Tinker's work to these and other modern writers, that urge has been resisted since that aspect lies in future work.

My definition of the Zone of Optimal Typography came about through Professor Winn's insistance that if Tinker's work did not speak to a theory, it may be atheoretical. This created a gnawing mental irritation which required solution. I did not see Tinker's work as atheoretical, yet I could find no statement in his own work addressing theory. Nor could I find a theoretical statement elsewhere (Hartley, 1987; Jonassen, 1982; Spencer, 1987; etc.) which fit my model of the structure formed by Tinker's work, although I felt certain one existed.

Eventually this conundrum resulted in my evolving the concept I call the Zone of Optimal Typography, based, for the moment, on the work of Miles Tinker suggestsan open-ended research agenda. Since I saw theory, but could not locate a name for it, I could only surmise that, as a designated theory, it was my own theory which required definition. I believe researchers in this field (educational technology) have, and Tinker himself had, a similar idea in mind. Work on this concept as theory lies in the future.

Studying Miles Tinker has been an unexpectedly fruitful activity for me personally. My chief interest was initially in Tinker's research on typographical factors. I had not realized th. appoximately half of this segment of his work was co-authored by Donald Paterson, the son of deaf parents, who had begun his work with Rudolf Pintner. I realized when surveying the scope of Tinker's work, with and without Paterson, that the Zone of Optimal Typography extends beyond typography per se, into ergonomics and illumination.

While studying Tinker, I received guidance on unanticipated issues such as how one might live a fulfilling professional life. I have learned more of the value of close personal professional relationships and have taken pleasure in seeing Tinker's quiet recognition of quality

in others. Tinker was a modest man who demonstrated wisdom and accurate judgement in his life, beyond education and beyond individual circumstance. Seeing truth in the human condition is a special gift which he appeared to possess. He was a contented man who was satisfied with a small amount of personal recognition. His persistent modesty and unalterable faith in the truth revealed by his work, was compelling.

Historical research carries with it certain recurring themes which reverberate in Tinker's life. One of these is the issue of how much an individual influences his own and later times. This dissertation is partially a biography of an experimental psychologist who stirred no great controversy in his own time. One might wonder why this man is worthy of special investigation. Biographies are usually reserved for "Great Men" (today, Great Persons).

E. G. Boring, Tinker's mentor at Clark University, defined a Great Man (sic) as an "agent of progress" (1950, pg. 744). However, he noted that,

> "The times must be working with him if he is to have success. He cannot, in fact, be successful without an audience, and he has to speak his wisdom in the right century or even the right decade to be heard."

Boring also said:

> "If the emerging thought is important, if it works its way well into human thinking for the next one hundred years, then the name of the man who owned the brain which had the insight becomes great."

What Boring did not add in this passage is that for a man to be appreciated, someone must write about him. An uncontroversial man who quietly finds truth during a time when only small numbers are able to utilize this truth is not likely to draw attention from other scholars. As the years have gone by, Tinker's *basic* work, the results of which modern scholars may seek, is seldom cited in current journals (Social Sciences Citation Index, 1966-1988). His review, Legibility of Print (1963) is alluded to most frequently, but only generally, never in depth.

Tinker owned the brain with emerging thought on the importance of typography in the reading process. This dissertation presents Tinker's work in a light not seen before along with analyses

of the influences under which they originally developed. In evaluating this work, the historical approach allows insight into the significance of the interaction found in the classical historical themes of Zeitgeist (spirit of the times) and Great Person which are illustrated as much by Tinker's life as any other.

Multi-disciplinary work is challenging due to its eclectic nature. Interrelating information across the boundaries of history, biography, psychology, education, reading, printing, and graphic design, with suggestions of application to emerging technologies, has been a complex but rewarding task. Like Tinker, I believe in its value and continuing contribution to understanding the evolving human mind.

Acknowledgments

While the many years of dissertation acknowledgments render them cliche, the sentiment is no less sincere.

I owe the greatest debt to Professors William D. Winn and Stephen T. Kerr for their professionalism and excellence from which I have benefitted in ways they do and do not know.

I also wish to express my respect and appreciation for other committee members who have been there for me: Professors Rosemary McCartin, Charles Burgess, Donald Williams and John Whitehill-Ward.

Thanks must be expressed to Carol Anunciation and Pat Smart of the College of Education Graduate Office for their generous assistance through the bureaucratic maze.

Thanks are due to the Department of Educational Psychology, at the University of Oklahoma for encouragement and support during the final stages and completion of the dissertation.

My gratitude is extended to those who assisted me in gathering material on Professor Miles Albert Tinker:

Gail Peterson, Professor of Psychology, University of Minnesota, who provided access to Department files of Donald G. Paterson and Miles A. Tinker;

Lois Hendrickson and Penny Krosch, Archive Librarians, University of Minnesota, who assisted in gathering materials from files of Miles A. Tinker, Donald G. Paterson, and Richard M. Elliott; and

Stuart Campbell, who sent archival material on Tinker from Clark University.

Finally, much material was obtained through assistance from individuals in the Tinker family, who must receive special thanks.

To Katrina Tinker, for answering a second letter to her grandmother who was too ill to respond, providing me with a link to descendents of Miles Tinker and information on those descendants.

To Gordon Tinker, who spent hours helping me "see" his father, giving me insights to both Tinker the man and his personal life. Gordon trusted me with his highly treasured copy (hand written notes in the margins) of his father's dissertation after meeting me once.

To Karen Tinker Strelitz who simply and generously opened her father's personal and professional files, allowing an unknown researcher access to uncensored, unedited information about her father.

And, I am grateful to Miles Albert Tinker for his undaunted persistence in the search for answers to how people process typographical imagery under varying conditions and to Donald G. Paterson for his inspiration.

Dedication

To my father, Kenneth Lyle Wright, Ph. D.,
and my mother, Corrella Rosalie Charles Wright Alexander,
"cover couple" on the 1940 Tyee.

Introduction

In 1963, the International Reading Association presented a citation to Dr. Miles Albert Tinker for "a distinguished career which has enriched the teaching of reading and understanding of the reading process"

In 1973, Tinker was elected to PROJECT INNOVATION'S "Reading Hall of Fame."

In 1974, the Department of the Army Human Engineering Laboratory dedicated "Eye Movements and Psychological Processes" (Monty & Senders, 1974) to "Guy T. Buswell and Miles A. Tinker, early investigators of eye movements, whose efforts covered so much of the ground that sometimes it seems that there remains for us only the investigation of fine detail." According to these accolades, issued in his retirement years, Tinker was an expert in the field of reading.

A closer look at Tinker's *basic* research reveals that he did not conduct basic research on the processing of printed language, which is usually thought of as reading. Rather, he conducted an extensive series of studies on how typographical factors, eye movements, and illumination affected, or were affected by, processing of the print image. He did not, in his basic research, focus on content nor on how messages might be influenced by methods of teaching. He was interested in the conditions of reading and how these conditions affected the speed with which processing of type took place. He was also interested in how *improper* conditions caused fatigue on the part of the reader and how eye movements differed in response to varied typographical conditions.

Miles Albert Tinker was a Professor of Psychology at the University of Minnesota from 1927 to 1959. A look at the braiding of experiences which produced this researcher and his work reveals how researchers develop and how influences at strategic times in a young life can predetermine the course of that life. This story is more than that of a professor who maintained a line of research. It is the story of a person who was in the right place at the right time. It is about a man who developed relationships which strongly interacted with his own research drives. It is also the story of how research of value to a specific population may have little influence on that population due to lack of presentation in the right place and in the right form, rendering its interpretation incomplete.

Tinker lived the American dream. His life began in rural poverty and endured as a respected force within a great institution of higher learning. Review of his life shows the effects of power and influence, demonstrates educational mission, and shows how political misunderstandings complicate the search for multidisciplinary truth. While Tinker published voluminously in psychological journals, his findings did not make the jump from theory into the practice to which it applied. While Tinker's extensive research might be discussed in all textbooks on graphic design and typography, only a small portion of his work is mentioned, if any.

Study of sight does not revolve around analysis of reading. Similarly, visual perception of typographical imagery (logically as vital to understanding of reading as sight itself) is not best understood within a reading framework alone. On the other hand, reading specialists need to be aware of factors of sight and vision as integral parts of the reading process. Awareness of typographical factors is no less important. Misunderstanding of Tinker's work results from confusion between "print as language" and "print as imagery." Tinker did not study print as language. Print imagery is "working" imagery. As most commonly utilized (as text read for information), it is not enjoyed for aesthetic reasons except by specialists. Most people, including Tinker himself, viewed his typographical research as study of reading, which was, in truth, only a secondary aspect. In his time reading appeared as the most appropriate arena for application of his work.

Sless (1981) has criticized Tinker's work for erroneously separating image (in the form of print) from the message conveyed by the image. He saw the two as inseparable. The basis of Sless's critique is an assumption that image and message cannot be separated. Since reading is the interaction of written language with the mind of the reader, this would appear to be a just criticism.

In order to read, unless one knows Braille, one must first be able to see. Secondly, the reader must be able to perceive the image (in this case, type) as a familiar carrier of a message. Only then can one be concerned with interpretation of the message. Tinker's work appears to invalidate Sless's argument. In all Tinker's studies the language was non-problematic and the same. It seems logical to propose that the less problematic the imagery (e.g., the faster it can be processed), the faster the content contained within the imagery can be processed. Tinker's concern was not with content, but simply

recognition of imagery, and he appears to have successfully separated the two in his studies. His correspondence indicated that he expected his research to be applied by typographical practitioners.

Certain developments since the height of Tinker's career provide 1) new urgency for reviewing his work, 2) new justification for publication of his work in a form which can be used by increasing numbers of desktop publishers, and 3) necessity for development of a theoretical framework within which Tinker's work can be better understood. Theoretical changes also present new applications in the design of computer screens. Understanding the importance of Tinker's research to the area of reading does not lie within the area of reading itself, but within the area of visual perception of typography.

This dissertation focuses on implications of Tinker's life and work from a variety of perspectives. One of these perspectives is historical, both with regard to Tinker personally and as a prisoner of his Zeitgeist. Another perspective is a survey of his basic research, again historically, as it related to Tinker's own time and as it might be used today. The influence of Donald Paterson, for instance, is central to this investigation. The Zone of Optimal Typography serves as a definitive framework within which to clarify Tinker's work and to render it more understandable to both theorists and practitioners. Last, Tinker's basic research demands analysis in light of modern applications within educational systems and within new technologies which create an urgency for use of information provided by this forgotten early work. The dissertation suggests answers to several questions:

Main Questions

1) What insights do primary documents offer for understanding Miles Albert Tinker's Zeitgeist and qualifications as a researcher?

2) Why did Tinker's work not become integrated into graphic arts literature?

3) What guidance does Tinker's research, within the framework of the Zone of Optimal Typography, provide for modern educators with regard to factors which promote efficient processing of typographical imagery?

Subsidiary Questions

1. Early influences

1a.) What directions did Tinker's life take?

1b.) Who influenced his professional development?

1c.) What series of events and persons were responsible for Tinker's development into a professor at the University of Minnesota?

1d. [i.]) What dynamics were involved in the Elliott/ Paterson/Tinker triumvirate?

[ii.]) What role did each play in psychology at the University of Minnesota?

[iii.]) What role did Paterson play in Tinker's life and work?

1e.) What directions did Tinker's research take?

2. Research

2a.) Why didn't Tinker's work become a significant part of literature on typography?

2b.) How was Tinker and Paterson's research received by those in the graphic arts?

2c.) What do Tinker's results look like when displayed in typographical form?

3. Theory and application

3a.) What is the Zone of Optimal Typography?

3b.) How does Tinker's basic research contribute to this concept?

3c.) How might Tinker's work be structured within this framework?

3d.) What use might today's researchers make of Tinker's thinking, especially with regard to the Zone of Optimal Typography?

Definitions

Definitions include terms common to psychology. Printing terms, likely unfamiliar to the educator, are included for sufficient understanding of Tinker's work.

Behaviorism - a theoretical point of view that holds that the subject matter of psychology is behavior without reference to consciousness or mentalistic constructs. (Chaplin, 1985)

Cognitive psychology - the branch of psychology which includes the study of processes involved in sensing, perceiving, remembering, and thinking. (ibid.)

The Zone of Optimal Typography - a range of optimal conditions under which readers are able to most efficiently process typography. Efficiency may be attributed to factors of both nature (the abilities and limitations of the human visual system) and nurture

(early experience with typography). The antithesis is that factors outside of this Zone will render readers less efficient in their ability to perceive typographical imagery.

Foot-candles - the amount or level of illumination at a distance of one foot from a standard candle.

Graphic design - the art of designing to communicate with an audience visually.

Image - 1) a picture of an object formed by a condensing lens 2) a central or conscious experience similar to sensory experiences, but less vivid, and recognized as arising from memory. (Chaplin, 1985)

Typography - appearance, style or arrangement of printed matter, including type, line length, white space, and other factors.

Display type - type set larger than the text (usually 14 pt. and above), used to attract attention.

Italic - style of letters that slope forward.

Justify - to insert spaces between letters and words in such a way that all lines on a page are of equal length.

Leading - white space between lines of type, measured in points. Terminology left from old printers practice of putting non-printing lead pieces between lines to add white space.

Line length - the length of the printed line, measured in picas.

Lower case - the small letters in type. Terminology left from printers practice of putting cases holding small letters on the lower portion of wooden stands for easy access when setting type by hand.

Pica - a typographic measure frequently defining line length. Twelve points equal one pica, six picas equal about one inch (6 x .1660 = .996). Reference is often in singular form, a "twelve pica" line.

Point size - a typographic measure of print or leading. About 72 points equals one inch. Usually used in the abbreviated form "pt."

Print imagery - printed representations of verbal communication (i.e. print) perceived by readers during the reading process.

Text type - the main printed matter of a page or book (usually less than 14 point) as distinguished from headings.

Limitations

This study will not review all of Tinker's research. It will focus on his early typographical studies with consideration for other work as it relates to these studies. It will not represent an in-depth analysis of any one aspect of Tinker's life or work except as related to qualifications and results. The nature of the typographical analyses

and their relevance to diverse areas of study necessitates a survey approach rather than an in-depth study of factors involved in this report. The detailed information on Tinker's early life and Paterson's hirings are for purposes of historical record and understanding of the character of each researcher and his situation at the time of embarking on the typographical studies.

The Zone of Optimal Typography relates, presently, to Tinker's work alone, and to that of no other writers past or present save the author. It is anticipated that aspects of this concept and of Tinker's life and work presented here offer avenues for future research which will undergo additional development at a later time.

Document Sources

Tinker's published research has been collected from professional journals (The American Journal of Psychology, Journal of Applied Psychology, and other psychological and education journals). Tinker's place in history was determined through primary sources (letters, documents and memorabilia) obtained through Tinker's family and the Department of Psychology at the University of Minnesota.

All documents are in good condition and their acquisition was conducted with permission. They include:

1) Copies of all published work available from professional journals (approximately 150 articles),

2) Complete document set of letters from the files of Miles Tinker and relevent parts from that of Donald Paterson, from the Department of Psychology at the University of Minnesota,

3) Complete document set of congratulatory retirement letters from students, co-workers and ex-professors of Miles Tinker (107 pages total) provided by the Tinker family,

4) A copy of Tinker's original dissertation completed at Stanford University from the library of Gordon Tinker,

5) Original instructional materials (workbooks) from the Experimental Laboratory at the University of Minnesota written by Miles Tinker, Director of the Laboratory,

6) Materials (books, pamphlets, etc.) from the Archives at the Walter Library, University of Minnesota,

7) Reference listings from: Social Sciences Citation Index (1966 to present), Psychological Register (1932), Dictionary of Contemporary Authors,

8) Set of correspondence with Matthew Luckiesh, E. G. Boring and other Tinker contemporaries from the files of Katherine Howland

Tinker, now in possession of Clifton Tinker, San Antonio, Texas, referred to in the text as "Tinker family files,"

9) Modern references: assorted materials from psychology, printing and graphic design, and computer screen design.

10) Other non-Tinker references to establish Tinker's place in history and to substantiate claims made in the dissertation.

Purpose

The purposes of this dissertation are:

1) to present evidence that Tinker was a well-trained experimental psychologist who worked within the mainstream of psychology while conducting research within a specialized area. Unexpectedly, files from the University of Minnesota were found to contain historical material not originally anticipated which gives a unique view, especially of those involved in Tinker's early professional development. Analysis of these materials allows insights into and understanding of influential men and women who set the tone for development of the new young science called Psychology early in this century,

2) to show how Tinker's methods developed through a survey of his original early Series in the Journal of Applied Psychology co-authored with Donald Paterson,

3) to demonstrate, with the aid of graphic arts literature, why Tinker's (and Paterson's) work did not significantly impact that area. Although his work is not infrequently mentioned by those who do discuss research, it is neither appraised nor analyzed appropriately in relation to its scope and comprehensive nature with regard to the process of reading,

4) to propose a conceptual framework, the Zone of Optimal Typography, within which Tinker's work may be organized. Optimal in this context means the conditions under which typography may be read most efficiently,

5) to present a complete record of Tinker's articles, books, and book reviews in one place. A listing of some of these works is not presently available in the literature,

6) to visually demonstrate some of Tinker's results within the body of this dissertation and its appendices, and

7) to produce the dissertation with state-of-the-art technological innovation not available in Tinker's time but to which his findings may be applied. This last is particularly appropriate because this dissertation is being produced under the auspices of the

area of Educational Communication and Technology. Tinker's basic typographical research is more usable by a greater number of people today than in his own time due to these emerging technologies. No book presently available offers Tinker's research results in its typographical form, even Tinker's own work. While complete presentation lies in the future, some representation is included here. Tinker's own work is incomplete: first, because it lacks ample visual presentation of what it discusses, and second, because he did not create a structure within which to understand the meaning of the results of his extensive inquiry.

It is not a purpose here to make detailed connection with modern theory. That connection is anticipated in future work and extends beyond the scope of this investigation. It will be suggested, however, that Tinker's research is classic, was ahead of its time, and more relevant today than at any time in history.

This theory is usable by a diverse audience. Today, "intellectual **printers,**" especially those responsible for training practitioners for the printing trade within educational settings , are aware of the importance of scientific research, if only to validate traditional choices. For the **teacher of reading,** identifying visual factors which allow early and mature readers to read most efficiently, and/or identification of factors which simply *don't slow readers down* are significant issues. For **graphic designers** the concept of the Zone of Optimal Typography offers a conceptual tool for use in making decisions when designing for educational purposes. Designers can then utilize specific attributes of print media which cause readers to increase or decrease speed under specified conditions, enabling decisions based reliably on desired outcomes.

For the new **desktop publisher,** the Zone of Optimal Typography provides guidance to untrained people who are learning to make good design decisions, especially important to those producing educational materials. Poor decisions based on misinformation and inadequate intuitive judgments are avoidable. A basic set of guidelines assists in development of judgments which can be confidently made.

Even **designers of computer screens** (and software) can profit, not only in relation to typographical considerations, but also from Tinker's and other modern studies on illumination and eye fatigue. Tinker's methods are usable by researchers today and provide guidance for future research. Cognitive studies still rely on

speed of processing coupled with accuracy of feedback. These techniques are classic in psychological test design, remain evident in today's theory testing, and have not lost their validity. Modern researchers may gain new ideas from looking over the array of print factors studied by Tinker.

Now that print has taken on new forms (e. g. computer screens) and control of print parameters is available to a mass of untrained **personal computer users** (via desktop publishing), investigation of print has taken on new dimensions which beg to be addressed. Review of the already neglected past in the form of Tinker's original work is a first step in this line of inquiry. Developing this work into a modern theory is the second and lies in the future.

My speculation is that Tinker would interpret his own work differently with the availability of a cognitive framework which did not exist in his own time. Gordon Tinker (1988) said that his father did not agree with B. F. Skinner's theories on behaviorism. His work demonstrated little of the attempt to change behavior common to his behaviorist times. Rather than asking "How can we change subjects?" Tinker and Paterson asked "What does the subject need in order to perform optimally?" The Zone of Optimal Typography structures these early investigations and defines this need.

CHAPTER 1

Massachusetts to California
1893-1927

Early Life

Miles Albert Tinker was born fourth of nine children on August 22, 1893 in Huntington, Massachusetts, to Benjamin Franklin Tinker and Katie M. Hoag Tinker. His family called him "Albert". The naming of his father after a famous printer perhaps foretold Albert's destiny: a life spent studying print. In any case, Benjamin was not a printer, but a poor farmer with nine children to feed. He could not always support his family by farming and sometimes, during the lean years, he was forced to work elsewhere. This family had no resources for sending children to college.

Albert showed his academic interests early. Reflecting on his school years in writings to his grandchildren, he said:

> "In the intermediary grades we studied reading, geography, history, arithmetic and spelling. The books were few and old. Soon I wanted to read more, but could find no books either in school or at home. ...
>
> I cannot say I ever learned much at this one-room school. The teachers were untrained and ineffective. Also, the materials for learning were poor and scarce. But the Superintendent must have seen some promise in me for, when I had finished the sixth grade, he arranged for me to go to the town school. It was 1-1/2 miles to town. Some of the time I walked, and sometimes I drove a horse.
>
> It was fortunate that I had this opportunity, for the teachers were good and I learned much. ..The school days in the country one-room school had been happy ones. I always liked school, even when the teaching was poor."
>
> (Miles Albert Tinker, 1893-1977, "Memories and Memorials", preface by Katherine Howland Tinker, Tinker family files.)

College was no last-minute decision on Albert's part. Rather than attend Huntington High School near his home, he traveled 12 miles to Westfield High School, which had the accreditation he

needed in order to be accepted by a college. He was the only one of the Tinker children to graduate from high school (1912). (Personal communication, G. Tinker)

Albert experienced some instability in his early adult life, attending Northern Ohio University while living with an uncle, 1914-1915, and again, 1917-1918. After a brief (six-months, 1918) stint in the U. S. Naval Reserve he was discharged when he developed a duodenal ulcer. (V.A. records, Tinker family files.) Finally, in 1919, he returned to Massachusetts to attend a local college 75 miles from the family farm.

Clark University -- 1919 to 1922

Tinker's attendance at the local college, Clark University, set off a chain of events and interactions which was to determine the course of his life. While the events are interesting in themselves, they include revelations about the character of early psychology and of the personalities involved in its development. Names like Hall, Sanford, Boring, Titchener, Miles, and Terman remind readers of accomplishments which allow little insight into the character of the individual men. While studying students of these men, their character is revealed through recorded interactions with students like Miles Albert Tinker.

While attending school, Tinker supported himself by working for the Strathmore Paper Co. and the Clark University Book Store. His greatest interest lay in studies of the natural sciences. Tinker's attendance at a university whose president was a world leader in the new science of psychology adds predictability to what this hard-working, ambitious new student who enjoyed people might accomplish in life.

Influences at Clark University

Tinker received a fellowship to attend Clark University through James Porter, a professor at that institution. Although University President G. Stanley Hall retired soon after Tinker began at Clark (1920), Tinker came under his influence in two ways. First, he attended an institution saturated with Hall's influence. Secondly, he trained under Professor Edmund Clark Sanford (1859-1924), who was trained by Hall. And Tinker was one of many whose lives were strongly influenced by E. G. Boring. Tinker-Boring correspondance extends from graduate school days through retirement. These were the primary formative influences in Tinker's life at Clark University.

Hall

Although not directly responsible for Tinker's education, G. Stanley Hall was one of the great figures of American psychology. Like Tinker, he was born on a Massachusetts farm. His training of and simultaneous tenure at Clark with E. C. Sanford, reveals the closeness of the two men.

Aside from serving as President of Clark University, Hall was responsible for many American "firsts" in the history of psychology. He received the first American doctorate (1878) in psychology, and was the first American student in the first year (1878) of the first psychology laboratory in Leipzig, Germany, run by Wilhelm Wundt who became known as the father of modern psychology. Hall began the first psychology journal in America entitled, appropriately, the American Journal of Psychology (1887) and became the first president of the American Psychological Association (APA), which he was instrumental in founding in 1892 .

Other journals founded by Hall were: Pedagogical Seminary (1891) (now the Journal of Genetic Psychology), the Journal of Religious Psychology (1904), and the Journal of Applied Psychology (1915). When Hall retired from the presidency of Clark University in 1920, Tinker had been there one year. Hall's main interests were in human and animal development and adaptation. He was a leader of the Child Study Movement, the beginnings of empirical study of children and their psychological development. He discussed recapitulation theory, the belief that a child's development emulates that of the human race, as early as 1904 in his monumental, two-volume, Adolescence (Schultz, 1975). This line of influence, especially concern with child development, is reflected in Tinker's own work.

Tinker's future was influenced directly by his experience with Edmund C. Sanford and Edwin G. Boring, two pioneers in the history of psychology whose tenures overlapped briefly during Tinker's training.

Sanford

Sanford was the first great influence on Tinker's development as a researcher and perhaps the longest lasting one. Sanford's own training with Hall at Johns Hopkins was completed in 1888, the year Hall became president of Clark. Sanford followed Hall to Clark, becoming the head of the experimental laboratory, as Tinker would later do at the University of Minnesota. His forte was the building of apparatuses, another future Tinker strength. In 1909 he became

president of Clark College, the undergraduate institution. He retired along with Hall, in 1920. Boring (1950) said that Sanford's pioneering Course in Experimental Psychology, heavily emphasizing sensation and perception, served as a model for psychologists across the country for thirty years after its publication, a significant feat for an early text in a rapidly evolving area of study.

Tinker, again emulating his early mentor, later developed his own laboratory manuals, with and without co-authors. Unfortunately, Sanford died in 1924. His last letter to Tinker in December of 1923 revealed his continued drive to analyze thinking processes:

> "The problem is this: is it possible for one to break away suddenly from a train of thought and take up another which is wholly unrelated to it, that is, one which is not connected with the first train of thought by associative links whatsoever?"

He proposed a method for Tinker's investigation and ended with:

> "... Of course, what one got would very largely depend on introspection. If something of this sort should interest you, try it out and let me hear how you get on." (Letter, E. C. Sanford to Miles Tinker, December 20, 1923, Tinker family files.)

If Tinker did try Sanford's idea there is no record of it, but this letter reveals one approach Sanford took to investigation.

Tinker's doctoral dissertation cited Sanford's "The relative legibility of the small letters" (1888) which appeared in the first volume of G. Stanley Hall's American Journal of Psychology.

Boring

Edwin Garrigues Boring, another mentor at Clark, had studied with Edward Bradford Titchener, a strong personality in American psychology, at Cornell University. Titchener published often in Hall's American Journal of Psychology and later became its Editor. Titchener's methods became known to Tinker through these two avenues. Tinker nearly studied with Titchener for his doctorate, but chose Stanford University (and Lewis Terman) instead. Correspondence between Titchener and Tinker will be discussed later, allowing a direct look at Titchener's personality as part of the atmosphere of early psychology.

Titchener had a tremendous influence on Boring, as he did on all of his students. Understanding Titchener aids understanding of Boring's approach to Tinker. Like G. Stanley Hall, Titchener had studied with Wundt in Leipzig. When he returned to his native England, he was not accepted, so he moved to America to set up his own school. Titchener emulated Wundt, the master, in his teaching. He was a domineering man who refused to integrate into the mainstream of psychology in America His influence was sustained through his students (like Boring) who became influential. His primary influence died with him (Boring, 1950, Schultz, 1975), but his domineering manner left its stamp on a portion of the character of early psychology.

Boring did not seek to emulate his mentor in his own interactions with students. In fact, Boring proved to have quite the opposite personality. While he did not feel it was in his own interest to fight Titchener, neither did he wholly approve of his behavior. There is no indication in any of his extensive correspondence with Tinker that he ever inflicted this same uncompromising attitude on his own students. Tinker's later decision to attend Stanford rather than Cornell may have been influenced by his mentor's (Boring's) sentiments, or at least by knowledge of the severity of Titchener's methods no matter how much Tinker may have wished to emulate Boring, for whom he had the greatest respect.

Tinker's work with Boring at Clark University included sensory perception. However, Boring's rather eclectic list of publications from the Psychological Register of 1932 does not enable a pinpointing of influence on Tinker's study of visual perception of print. Boring more certainly influenced interest in the history of psychology, which continued throughout Tinker's life.

Like Elliott, Paterson, and Terman, men who would later figure prominently in Tinker's life, Boring was a member of the fraternity of World War I psychologists many of whom became famous as leaders of this developing science. His interests included perception of various sorts, not heavily focused in any one area except psychology in general. They ranged across a variety of sensory reception, dementia praecox (known today as schizophrenia), testimony (law), mental measurement, apparatuses (another influence on Tinker), statistics, and history, this last beginning noticeably in 1927 with the death of Boring's mentor, E. B. Titchener.

Tinker was an excellent student at Clark, serving as Assistant in the Experimental Lab. When he graduated he was one of four listed with "First Honors" (A.B.) in 1921 and as one of two graduating "With High Honor" (the best of the best) in 1922 (A.M.). Interestingly, his Master's thesis, carrying Boring's signature as advisor, comprised 15 pages. It was an experimental study entitled A Study of the Relation of Distracted Performance to Performance in an Intelligence Test. He compensated for this small quantity when he wrote his doctoral dissertation.

When he graduated from Clark University, Tinker wanted to follow his mentor (Boring) to Harvard. Sanford was retired and Clark University was in the midst of political upheaval following the loss of both Hall and Sanford. Tinker's search for a doctoral education and reasons for his eventual attendance at Stanford are revealed in letters between Tinker and Boring.

Boring advised Tinker about study after graduation from Clark, in a letter dated October 14, 1924. Tinker had suffered from a duodenal ulcer for which he had received discharge after brief service in the U. S. Naval Reserve (1918). He took a year off in 1924 to have an operation and to recover. When he was well enough to apply to graduate school, Boring wrote that others had seniority for fellowships and Harvard had little else to offer.

Boring listed alternative institutions for doctoral study, along with his opinion of each. These included Harvard, Cornell, Clark, Stanford, Michigan and Minnesota. He remarked on Clark's political problems and held out little hope for a fellowship at his own alma mater, Cornell (with Titchener). His strongest recommendations were for Stanford and Minnesota:

> "I think that Stanford and Minnesota are the two promising places in the country, hoping of course in the back of my head that it is modesty that makes me leave Harvard out."

About Stanford:

> "They are a live bunch working very harmoniously together in the spirit of research. ... You would not have to limit yourself to dissertation with Terman; you could work in experimental psychology with (W. R.) Miles or in animal psychology with Stone, both of them first-rate men."

"Experimental psychology with Miles" must have attracted Tinker's attention. Boring added:

"At Cornell, however, it would be futile for me to write except in connection with your application for a scholarship. If Cornell had an assistantship, I would have nothing to do with it unless Titchener wrote me, as he would most certainly do in the event that he did not have the right man himself."
(Letter, E. G. Boring to Miles Tinker, October 14, 1924, ibid.)

Apparently either Tinker or Boring wrote Titchener, because correspondence in Tinker family files verifies that Tinker was indeed offered an assistantship with Titchener. Although Tinker had already decided to go to Stanford at the time of this correspondence, it is reviewed because of its historical contribution. The interaction which took place between the two men demonstrates Titchener's personality and professional conduct. This correspondence also supports Tinker's qualifications as a prominent candidate for entry into several top institutions for study of psychology in America.

Titchener

Titchener advocated observation, introspection, and experimentation as prime modes of discovery in psychology. For Titchener, all of psychology revolved around the experiencing person's study of consciousness. While Boring was Tinker's primary influence, Titchener was such a domineering force that he must be considered a secondary influence.

Offending the domineering Titchener was risky at a time when few institutions of higher learning offered Ph. D.'s in psychology and when Titchener was editor of the American Journal of Psychology, a potential arena for publication.

Early in his search for a graduate program, Titchener had written, in response to Tinker's inquiry about a fellowship:

"I doubt very much whether we shall give a fellowship this year..."
(Letter, E. B. Titchener to Miles Tinker, February 26, 1925, Tinker family files)

When a fellowship offer from Titchener finally arrived, it came only after Tinker had accepted a fellowship offer from Stanford. On June 9, Boring congratulated Tinker on his acceptance at Stanford University, noting that Titchener was upset at Tinker's refusal of the offer of a fellowship at Cornell. (Letter, E. G. Boring to Miles Tinker, ibid.)

June 17, 1925 brought an angry letter from Titchener, apparently written in response to an apology from Tinker (presumably due to Boring's comment above) for not notifying Titchener that he had applied for fellowships at universities other than Cornell. While Titchener acknowledged Tinker's apology, he then elaborated on fellowship procedures and his displeasure at Tinker's refusal of his offer.

> "We had not the least idea at this end that you were applying elsewhere as well; the Dean had no intimation to that effect, and neither Dr. Pratt (who was very much interested in getting you here, and who wrote several very good letters about you to me) nor Dr. Boring gave me any hint that you would not come if you were appointed.
>
> We never consider a candidate unless we are sure that he will accept the position if he is elected. When I am in doubt in the case, I always make it a point to write to the candidate beforehand, to make sure; but in your case it did not, for the reasons just given, enter our heads that you were not anxious to come in case of election."

Titchener stated that some of the fault may lie with himself for the mix-up since he had not checked with Tinker prior to offering him the position, but he personally accepted no blame. He then detailed the irritation inherent in selection of Fellows and the inconvenience caused when they declined. After his extensive monologue about the inconvenience caused by Tinker's lack of consideration, Titchener ended with:

> "Don't bother about us any further; we were able to replace you without any special trouble" (!) "and we were all quite sure that you acted in ignorance of our regulations. I am, as I said at first, glad that you have written to me personally, so that the whole thing may be cleared up; let it now stand as cleared up, and forget all about it."
>
> (Letter, E. B. Titchener to Miles Tinker, ibid.)

Titchener had apparently forgotten that he had indicated a necessity for Tinker to seek a fellowship elsewhere in the letter of February 26, 1925. It is unknown whether Tinker pointed out this fact in his apology, but Titchener at least appears to forgive Tinker his

grievous error in not notifying Cornell in spite of the fact that Titchener had earlier indicated that Cornell had nothing for him.

Titchener was, according to Boring, an unforgiving person. Boring said, about personal experience with Titchener as a professor:

> "Many of his (Titchener's) more able graduate students came to resent his interference and control and eventually rebelled, to find themselves suddenly on the outside, excommunicated, bitter, with return impossible. Quite early in our married life my wife and I decided that we would accept "insults" and arbitrary control from Titchener in order to retain the stimulus and charm of his sometimes paternal and sometimes patronizing friendship.
>
> I never broke with the master and I still feel that the credit balance remained on my side. ... Titchener's friendships (like Freud's) were authoritarian and paternal."
>
> (Boring, (1968)

Tinker, who was not a man to enjoy difficulties in his relationships with people, may have been just as happy not to have accepted a fellowship at Cornell. He had inadvertently committed what might have proven to be a costly and unfortunate error. Aside from his own chastising, Titchener requested that Boring scold Tinker for this error, which Boring did, dutifully and unconvincingly. He held out hope, not necessarily for Titchener's forgiveness, but for his forgetfulness, seeking to ease Tinker's worry over the incident.

> "I think Titchener will forget the matter in a year or two, and even if he should not, no particular harm will be done. One's professional career is scarcely affected at all by any one other individual."
>
> (Letter, E. G. Boring to Miles Tinker, June 9, 1925, ibid.)

Boring finished:

> "Just go on out to Stanford and make a new group of friends to add to those you already have."
>
> (ibid.)

Einstein (in Planck, 1949) made a point about rigid thinking which appears related to Titchener:

> "New scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die."

Titchener demonstrated the same attitude toward selection of graduate students as he did toward psychology: there was only one way.

Minnesota had also been interested in Tinker as a graduate student. In a letter dated November 10, 1924, R. M. Elliott (University of Minnesota) acknowledged Tinker's fellowship application, stating " I doubt that any of our assistants average as high as twelve clock hours per week" and asking Tinker to fill out a personal report card. He said there were seven assistantships available (Letter, R. M. Elliott to Miles Tinker, ibid.).

As if looking into the future, Boring noted that Elliott, "has my view of the matter and I think most of the younger people have...," that it is expected and acceptable for students to apply to more than one place. But he cautioned Tinker,

> "you ought to know about Titchener since it is part of your education against performance in the future." (ibid.)

Tinker's files included no resentful letter from Elliott, and his later hiring at Minnesota would appear to indicate that there was no lasting resentment over this issue on Elliott's part. In fact, his early application may have convinced Minnesota that Tinker's interest in that institution was genuine and long term. As it happened, Titchener died two years after this incident. And Tinker went to Stanford.

Marriage

Immediately prior to leaving for Stanford, Tinker married. Blooming late in his personal as well as professional life, Tinker married for the first time at age 32, (he received his Ph. D. at 34). His wife Eva was from his home town, Huntington, Massachusetts. She was a friend of his sister, Emma. "Albert" had been dating another woman, but one romantic evening he was with Eva when she suggested they get married and he agreed (Personal communication, Gordon Tinker, May 18, 1988). They were married June 14, 1925.

Boring expressed concern over Tinker's marriage, worrying that it might provide too much pressure in addition to his work at a top graduate program such as Stanford's. This did not prove to be the case, however. In fact, it was likely Eva helped with secretarial tasks which actually lightened Tinker's load. Eva never fit into academic life very well. She was a small-town girl who felt uncomfortable in the academic environment. Nevertheless, she went with Tinker to Stanford. (ibid.)

California

Terman

One of Hall's most famous students, Louis Terman, had gone to Stanford in 1910 and was well along in the development of his I. Q. scales (first edition, 1916) by the time Tinker attended Stanford for his Ph. D. (1925-1927).

Lewis Terman's influence was not reflected in personal correspondence with Tinker, but Tinker's gratitude and high regard is reflected in a story which he wrote in response to a letter from May Seagoe, who was working on a biography of Terman. Tinker reflected on life at Stanford and on Terman in particular. This letter is recorded in full for historical purposes and for insight into Tinker's attitude toward Terman and his life at Stanford.

> "When I first arrived at Stanford University in 1925 as a graduate student, Dr. Stone warned me that Dr. Terman had a formal relationship with students and that I would not be able to see him until his regular office hours. This sounded rather formidable but when I did see Dr. Terman he gave me a warm welcome. However, I was warned to always address him as Dr. Terman. This held all the time until I obtained my Ph. D. degree (directed by Dr. Walter R. Miles).
>
> Throughout the two years I was never invited to Dr. Terman's home for an informal gathering. I did attend his evening seminars which met every two weeks at his home. The seminar meetings were always rather formal. Dr. Terman was always helpful in promoting the welfare of the psychology graduate students. It was he who suggested and recommended me for the job of "The Hygiene of the School Child" in the College of Education. I taught this course twice a year for two years during the winter and summer quarters."

While Boring surely planted the seed (Tinker was on the Biography Committee at Clark, 1920-21), Tinker's active participation in historical research apparently began at Stanford:

> "While at Stanford I became interested in the history of psychology. At my suggestion, B. D. Thuma, P. R. Farnsworth and I decided to do a minor study on the Rating of Psychologists. I went to Dr. Terman and discussed the project with him. He was enthusiastic,

suggested a few extra names to include, and said the Department would stand the expenses of the study. This is an example of how Dr. Terman promoted the activities of graduate students who were his own advisees.

Dr. Terman was helpful in many ways. On as (sic) Easter vacation, a group of married students went to Carmel for two weeks of recreation and to work up some data on another joint research project (Speed in reaction time as related to performance on intelligence tests).

I had a Model T Ford. On the way to Carmel I was arrested for exceeding the 15 miles per hour speed limit in Gilroy. It cost me $15.00. This was most of my spending money for the vacation period. Dr. Terman had a cottage at Carmel and was there during the Easter holiday. I went over to his cottage and told him just what had happened. Immediately he loaned me money for the vacation. He said that Gilroy was noted for being a speed trap for motorists."

This letter also revealed the reason that Paterson took such an active role in Tinker's hiring rather than the department Chair, Elliott:

"When I obtained my Ph. D. degree, Dr. Terman was very much pleased to know that I had secured as (sic) appointment as assistant professor at Minnesota. During my last summer at Stanford (while teaching the Hygiene course during summer school), Dr. R. M. Elliott stopped to visit Dr. Terman on his return from a trip around the world. Dr. Terman arranged a luncheon party at a hotel in Palo Alto for Dr. Elliott and thoughtfully invited me to be present. It was a very pleasant meeting with the chairman of the Minnesota Department."

Tinker's modesty and understanding of his own situation were shown by his recounting of an incident when he received special assistance from Terman:

"A short time before I left Stanford, Dr. Terman called me into his office and gave me some advice. I had been brought up on a farm in Massachusetts and had acquired some mispronunciation of several words. Dr.

Terman had made a list of several of these words. He called my attention to them and pointed out that I should try to correct my pronunciations to improve my image as a University professor, noting that otherwise people would consider me ignorant. I was very grateful for his advice.

Twenty years after I obtained my degree I returned to Stanford for a visit. Dr. Terman had retired from the University, but still lived in his home on the campus. When I phoned him he invited me and my family to come for dessert after lunch. He and his wife were most cordial and he greeted me like a prodigal son, calling me by my nick-name of "Tink" and praising me for my accomplishments since leaving Stanford. I always sent Dr. Terman reprints of my publications and remember particularly his letter about one of my experimental reports ("Effect of visual adaptation upon intensity of light preferred for reading", 1941). In addition to congratulating me on my productivity, he stated that this report was one of the finest pieces of research I had done."

Tinker revealed his feelings toward the significance of personal interaction through simple yet memorable events:

"I have always admired Dr. Terman as a person, in addition to admiring his professional achievements. In spite of his formality with students, he was a warm-hearted person, generous in recognition of achievement, and solicitous of the students' welfare. For instance, soon after arriving at Stanford, my wife and I were visited by him and Mrs. Terman in our little apartment as an expression of concern about our comfort.

Another occasion likewise illustrates his solicitude. As was common practice, I was asked to report on my M. A. thesis at his seminar soon after my arrival. One of the members of the seminar criticised (sic) the statistics I had used in my experiment. Dr. Terman came to my defense, noting that the study was preliminary and basically sound.

I have always been grateful to have had contact with such an outstanding person as Dr. Terman. All

graduate students at Stanford admired him and most of them liked him very much whether or not he was their adviser."
(Letter, Miles Tinker to May Seagoe, January 18, 1968, ibid.)

Miles

No evidence has been found of Tinker's feelings toward Walter R. Miles, under whom he completed his dissertation. Tinker's history files contain several photos taken during various periods in Miles's life, indicating an on-going attachment to his Stanford mentor.

It was evident from the Psychological Register (1932) and his letter to Seagoe that the major direction in production of Tinker's doctoral thesis at Stanford came from Miles. Miles began publishing articles on eye movements in 1925, the year Tinker began at Stanford, starting with "Photographic recording of eye movements in the reading of Chinese in vertical and horizontal axes" with a graduate student, E. Shen, who studied these differences for his doctoral thesis. Prior to that study, Miles had been working on eye movement studies in conjunction with studies on alcohol and conditions of physical deprivation (Miles, 1919, 1924).

In 1926 Scientific American published Miles's "When reading your eyes move in jumps". Tinker attended Stanford from 1925-1927, completing his dissertation at the time the above articles were published. Tinker stated that his dissertation, An Experimental Study of Legibility, Perception and Eye Movement in the Reading of Formulae, stemmed directly from Miles's work (based in his beginnings with Sanford at Clark). He also said that study of reading at Stanford began with the 1925 Miles & Shen article (Tinker, 1927). Thirty years later (1955) Tinker published his own article on "Perceptual and ocular efficiency in reading materials in vertical and horizontal arrangements," a similar study to Miles and Chen's study (1925), perhaps attesting to Miles's long-term influence.

While Tinker's work at Stanford was somewhat a continuation of his work at Clark begun under E. C. Sanford, there was a great difference between his two mentors, experimentalists Sanford and Miles. Sanford was nearing the end of his career when Tinker studied with him. He was one of the old school (previously known as the "new school"), a philosopher who became an introspective scientist to pursue psychological study. Miles, on the other hand, was in the middle of an active career as one of the new

breed of psychologists who used observation of others in the seeking of truth. The Psychological Register (1932) listed his title at Stanford as "Professor of Experimental Psychology".

Born in North Dakota, Miles received his Ph. D. from the University of Iowa and taught at Penn College and Wesleyan University. He conducted research at the Nutrition Laboratory of the Carnegie Institution of Washington (Boston, Mass.) prior to arriving at Stanford University. During his eight years at Stanford (1922-1930), Miles produced close to 70 articles. While both Sanford and Miles were primarily experimentalists, their approaches were those of two different schools, both of which Tinker appeared to absorb successfully. He took the best each mentor had to give, putting them together in his unique approach, which likely underwent further modification under the influence of the dynamic Donald Paterson at the University of Minnesota.

The Interaction of Great People and Zeitgeist

The dynamics of Tinker's life, up to this point, illustrate two recurring questions which have intrigued philosophers throughout time. These two questions will continue to echo in his later life.

One question, personalistic, asks what might have happened without the Great People, people who effected influence within the context of a combination of opportunities which allowed them to develop and take the actions they chose? Opportunities alone are insufficient for personal accomplishment. How much effect can one person have on the world around him/her? Would another person have accomplished the same feats given the same conditions? How much responsibility does a Great Person him/herself truly bear for his/her apparent influence?

The other recurring philosophical question, naturalistic, asks what significantly different outcomes might have resulted from a set of circumstances other than those which existed at a given time. How much is Zeitgeist (literally "time ghost" or spirit of the times) responsible for a person's ability to affect his/her time? If opportunities were not available, would the same individuals have succeeded in similar accomplishments in other arenas or found another way to accomplish the same tasks?

The two questions are unanswerable and, like nature versus nurture, the truth is likely an interaction between the two. We can speculate on the interaction of Great Person and Zeitgeist in Tinker's life as his course is charted to a career at the University of Minnesota.

Whether the responsibility of Great People or Zeitgeist, Tinker began as a poor farmer's son and found his way through the doctoral program at Stanford, completing this segment of his life by obtaining a professorship at the University of Minnesota. Education is expensive. Fellowships are not guaranteed by hard work, though available fellowships are not usually offered without it. Tinker's future career in psychology would not have been as likely if, for instance, he had been born in Ohio or Arizona. His attendance at one of the earliest and foremost institutions for the study of psychology in the United States, Clark University, would have been unlikely for a farmer's son growing up far away from the shadow of that institution. He did not accomplish his goals without assistance from others who were, effectively, Great People in his life. His letters of recommendation have indicated that he was a hard-working, intelligent man who got along well with others. He appears to have been well-trained in the methods of his day by top people in his specialty, experimental psychology.

What might have happened if Tinker had not attended Clark University and been influenced by the Zeitgeist at that institution? Would he have still ended up in psychology or in some other scientific capacity?

What might have happened if Tinker had attended Clark in earlier years than the brief tenure (1919-1922) of his mentor, E. G. Boring, or later than E. C. Sanford (1888-1924)? He certainly might have done either, considering his age. It was Boring who suggested that Tinker seek his future at both Stanford and Minnesota, and it is apparent that Tinker followed that advice. His experience with apparatuses learned from Sanford and Boring enabled him to strengthen his marketability for Stanford and Minnesota.

If Tinker hadn't been near the end of his doctoral work at Stanford when a letter of inquiry arrived from Donald Paterson his name would not have been mentioned as a possibility when Minnesota inquired of Terman who he would suggest for the opening they had which Tinker subsequently filled.

Tinker had applied to graduate schools at Minnesota and Cornell. While he could conceivably have gone to Minnesota if he had graduated from Cornell, letters between Stanford and Minnesota indicate that Minnesota particularly wanted a graduate recommended by Terman specifically, and Stanford in general.

The desire for a Stanford graduate may have stemmed from the earlier employment of Florence Goodenough , who had graduated from Stanford in 1924. It was unlikely that Minnesota would have hired Tinker if he had graduated from Minnesota since colleges traditionally prefer to send their graduates out into the world to prove themselves. Letters from Minnesota gave no indication that they considered hiring any of their own graduates at that time. If he had not gone to Minnesota, would Tinker have conducted such extensive studies on typography? Without his co-author, Donald Paterson, Tinker's son Gordon didn't think so (Personal communication, 1988).

The next stage of Tinker's life consisted of a long, steady career at Minnesota conducting the experiments he loved so much. It was apparent from his Clark days that experimental psychology was his career of choice and he never waivered from that course, a course strongly impacted by interactions with Paterson and Elliott and which is best understood within that human environment. As will be seen, the interaction of Great Persons and Zeitgeist continued at Minnesota.

CHAPTER 2

The Road to Minnesota

The journey from Stanford to the University of Minnesota took place under the auspices of Donald Paterson who was to become influential in Tinker's research agenda. Although this dissertation focuses on Tinker, Paterson was such a powerful figure within the Department of Psychology at Minnesota and became such a close colleague of Tinker's, his influence cannot be minimized. Understanding this relationship requires a review of the history of these men, along with the third part of the triumvirate, Department Chair R. M. Elliott.

"Mike" (Richard Maurice Elliott), "Pat" (Donald Gildersleeve Paterson) and "Tink" (Miles Albert Tinker) were the backbone of the Minnesota Department of Psychology for over thirty years. Mike, viewed as an upper-crust New Englander by his peers, chaired the department, while his editorial connections with Appleton-Century-Crofts (psychology series) promoted publications by those within his department. Pat's dynamic influence permeated psychology, particularly testing and applications, throughout the University. Tink was the quiet dependable one, who ran the experimental laboratory so efficiently during his tenure at Minnesota that Mike never had to concern himself with that facility.

Elliott

Paterson conducted the search involving Tinker because Elliott was on a trip around the world. "Mike" Elliott began chairing the University of Minnesota Department of Psychology in 1919, the same year Tinker began his studies at Clark. Elliott's former professor, Robert Yerkes, had been appointed to head the Minnesota department two years before, but elected to stay in Washington, D. C. after World War I to head up the National Research Council. Yerkes had become a powerful figure in psychological testing as a result of his war work. He suggested to Dean John B. Johnston of the College of Science, Literature, and the Arts that Elliott would make a good choice to replace him as head of the department.

Elliott had been trained at Dartmouth and Harvard, receiving his Ph. D. in 1913. Like Tinker, he was a middle child from Massachusetts. Unlike Tinker, his family was not only comfortably situated, but all five children were well-educated. His mother

graduated from normal school and his father was a respected businessman. Four of five Elliott children were Phi Beta Kappa.

Elliott's scientific interests, like Tinker's, began early in life. Astronomy captivated him, but he could not handle the math and physics involved, so he resigned himself to study of high-verbal subjects like Latin and Greek, and majored in philosophy-psychology at Dartmouth.

At Harvard, Elliott studied with Hugo Munsterburg, another student of Wundt, from 1882 to 1885. Titchener did not approve of Munsterburg, (no great criticism considering that he approved of few other people) charging that he misinterpreted Wundt. On the other hand, William James, in a demonstration of differing viewpoints early in the development of American Psychology, was so impressed with Munsterburg that he imported him from Freiburg to set up and run the experimental lab at Harvard. With interruptions, Munsterburg stayed there for the rest of his career.

Elliott completed his Ph. D. thesis on The Psychophysics of Handwriting. To his disappointment, he missed study with William James, who died one month before his arrival at Harvard. However, he attributes his strong belief in the importance of applied psychology to his training with Munsterburg. (Elliott, 1968).

In 1914 Elliott began assisting Yerkes at Yale University. From 1915 to 1918 he instructed at Yale , teaching general, experimental and genetic psychology. In 1918, he was commissioned First Lieutenant and sent to Camp Greenleaf, Georgia, where he served one month under Captain Donald Paterson. As chief psychological examiner at Camp Sevier in South Carolina, (now) Captain Elliott's success was made known to Washington, D. C. After the war Elliott went to Washington and, three months later, was recommended by Yerkes to chair the department at Minnesota. Yerkes also had recommended William S. Foster (another ex-Titchener trainee) and Mabel Fernald, who began work on individual differences, for positions at Minnesota. Foster taught experimental psychology and history of psychology from 1919 to 1925 when he died unexpectedly, opening the door for Tinker. Mabel Fernald's resignation in 1921 had opened the door for Donald Paterson. (ibid.)

When Elliott joined the University of Minnesota (UM) faculty in 1919, psychology separated from the department of philosophy. With his encouragement, psychology became part of the division of

natural science. Other professors already working at Minnesota, such as Lashley, who had been there since 1917 (also due to Yerkes' recommendation) and Woodrow (there since 1909) did not object. The new department met in what used to be the Department of Pathology. (ibid.)

Paterson

"...when Mabel Fernald resigned her post in individual differences in 1921 (I) knew at once whom we wanted if we could get him" wrote Elliott. Her emphasis on individual differences begged for maintenance by Donald G. Paterson, and Elliott began his fight to recruit Paterson who, by this time, worked for the Scott Company in Philadelphia, a psychological corporation.

Paterson received his training at Ohio State University (A. B., 1914 and A. M., 1915). From 1914 through 1918 he co-authored papers with Rudolf Pintner, a professor at Ohio State University who later moved to Columbia University.

Pintner and Paterson were influential in developing non-verbal tests for the deaf. Paterson's parents were deaf, rendering him invaluable as co-researcher in this effort. Paterson served as Captain and Chief Psychological Examiner for the U. S. Army from 1917-1919. Prior to World War I he worked for the University of Kansas; then for the Scott Company as a consulting psychologist. Planning on a career in industry, Paterson had not felt the need to finish his Ph. D. His experience and education were more than sufficient for a psychologist serving the business world. His qualifications in knowledge and experience, if not in academic accomplishment, were precisely what Elliott wanted. Aside from his academic qualifications, Pat was a dynamic personality, a good complement to the sedate New Englander who chaired the department.

Paterson's hiring into the Department of Psychology at University of Minnesota was of quite a different character thanTinker's would be, for specific reasons. The strength of Paterson's influence can be best seen through the eyes of Mike Elliott:

> "There can be no denying that the area from which the ubiquitously used stereotype 'Minnesota psychology' has arisen is, to adopt that familiar but ridiculously anachronistic term, applied psychology. It all flowered from the appointment of Donald G. Paterson. I had served as a psychological examiner under "Pat" in the army, (and) had followed in a general

way his work in personnel psychology for the Scott Company,...."

The dynamics of this hiring involved two issues. One, predictably, was money, as education tried to compete with industry. The other was Paterson's concern for team work on the part of his co-workers at the Scott Company and potential co-workers at Minnesota.

On May 3, 1921 Elliott wrote pessimistically about monetary possibilities at Minnesota,

> "Pat, must we abandon the hope of getting you if we can raise only $3500? I believe that $4000 is out of the question. I am very doubtful whether anything intermediate between $3500 and $3900 can be secured." (Letter, Elliott to Paterson, Paterson file, University of Minnesota Department of Psychology)

He explained difficulties in legislation, departmental allocations, and competition between salaries of those from industry and those who were already in academe. He continued that opportunity and potential enthusiasm for the work Paterson would do at Minnesota were excellent.

Paterson replied, side-stepping the money issue,

> "I have been fortunate in being associated with the work carried on by The Scott Co. There is a peculiar combination of abilities involved. We are all vitally interested in this work and enjoy working together for a common end. Because of this, each of us has developed a keen appreciation of the value of this type of association. I would be reluctant, therefore, to give up the inspiration that comes from such a group."

He continued, modestly,

> "This statement of my attitude should indicate to you that the credit for any work I may have done while a member of The Scott Co. belongs to the group as a whole. Furthermore, it should indicate that I would regret to sever my relationship with the company unless I could feel certain that such a step would fully compensate for the advantages I now enjoy. ... While I am not contemplating a change in the immediate future, yet I would seriously consider a definite proposal" (ibid.).

This last sentence leaves the door open to possibilities.

On June 4, 1921, Elliott sent an offer to Paterson:

> "Will you accept position assoc. professor of psychology. Salary 3600. No requirement of more than six hours teaching in differential and individual psych. Other work research c practice applic. of psych. to university and industrial personnel problems. Can assure you appoint c cooperation of university authorization. Would appreciate answer by wire collect."
> (Handwritten document, Paterson file, University of Minnesota Deptartment of Psychology)

On June 5:

> "Offer definite. Take due time / for decision especially if likely / to be in favor of / Minnesota. Anxious to have appointment / settled before leaving for Europe / next week. Foster in charge / then. Remember state salary not / subject to income tax. Letter / follows." (ibid.)

On June 10, 1921, Paterson wrote a letter happily accepting the offer from Minnesota, saying:

> "There are many elements in the situation that have a very strong appeal to me. ... So much depends upon one's associates in any kind of work and I feel very fortunate in this opportunity to work with and among your group. I have the highest regard for each member of your department and I am glad that there is no one set point of view controlling the situation. My own experience at Ohio State convinced me that a diversity in point of view is not only stimulating but very wholesome."
> (Letter, Paterson to Elliott, Paterson file, University of Minnesota Department of Psychology)

Paterson's later reticence toward an unknown man named Tinker when personal characteristics were in question (as per communication with Terman) was understandable considering the importance colleagues play in Paterson's life. A background in industry and a personal relationship with the department chair (consequently a knowedge of his experience) increased Paterson's marketability. No intermediary was needed to speak for him or to qualify his abilities. In their correspondence, Elliott mentioned

"Stone", the man who would later be instrumental in quelling Paterson's concerns about Tinker instigated by Terman.

Elliott continued about Paterson in his autobiography:

> "We did get him, and he has been at Minnesota ever since, and served as adviser to 44 out of our 103 Ph. D. graduates and 131 of the 216 holders of a Minnesota Master's degree in psychology. Never was there a closer fit between the interests and abilities of a man and a job that was crying to be done. The closest partnership developed between Paterson and me at the department level, and between Paterson and Johnston in the formation of University policies and practices based on a recognition of individual differences among students. Minnesota's pacemaking role in this area is widely recognized." (Elliott, 1968, p. 90.)

Elliott never regretted his recruitment of Paterson to Minnesota. He was proud of the "personnel psychology" which developed at Minnesota and which was so much a part of Donald Paterson. He recognized the coming of clinical and social psychology and the need for adaptation to change. His own heart was in the duality of biology and environment in the formation and development of a human being, but he reveled in the breadth of "his" department at Minnesota.

Between 1921, when he was hired at Minnesota, and 1927, when Tinker was hired, Paterson's published studies revolved around measurement and assessment. Once Tinker and Paterson were in the same department, the studies on typography began.

Tinker

The process of hiring Tinker began, early in 1927, when Paterson wrote Lewis Terman at Stanford University to inquire about candidates to replace Woodrow who was leaving the Department of Psychology. On February 16, 1927 Terman replied,

> "... you have laid out a pretty difficult set of specifications to fill on a $3000 salary!"
> (Letter, Terman to Paterson, Tinker files, University of Minnesota Department of Psychology)

Feminists today would be gratified to read Terman's first recommendation:

> "The best man I know who might possibly be got for $3000 to $3500 a year for work in individual psychology, is a woman--Dr. Catharine M. Cox..." "You

> doubtless know of Dr. Cox as the author of Volume II, Genetic Studies of Genius. ..... she has an enormous amount of energy and is an extraordinarily good teacher. There are few women teachers of psychology in universities who can attract able and mature man students to their classes. Dr. Cox can. Personally she is "pure gold." Cooperative, good humored, loyal." (ibid.)

He noted that she was probably 35 or 36 years old, used to teach German at Stanford, was very popular in that department, and was (currently making $3500, plus more teaching at the University of Cincinnati. He doubted that Minnesota could secure her services for less than $3500, but said they may try, and added that she may want an associate professorship.

Terman's second suggestion was Broyler, "whom you already know." He said Broyler was excellent in application of statistical methods to psychological or educational tests, and was presently an assistant to Thorndike at $3000. Broyler had lived with Terman for a year.

> "For character and all-around decency he is one of the finest young men I have ever known."

But,

> "His weak point is that he is not a particularly clear and strong classroom instructor, especially with elementary students." (ibid.)

Terman's next suggestion "only applies in case you are able to shift your department schedule around so that the new man could work in the experimental field" and he proceeded to recommend two men who were experimentalists.

> "I will not go into detail regarding this however until I find out whether such a shift is possible. I refer to Dr. Robert Seashore and Mr. Miles A. Tinker."

While Dr. Seashore was serving as a National Research Council Fellow,

> "Mr. Tinker will complete his work here for the doctorate this year. He is a young man of scholarly interests and good teaching ability but has not quite as cultivated a background as young Seashore." (ibid.)

Tinker was Terman's only recommendation of those who were still students. His other three suggestions were Ph. D.'s.

One week later, W. R. Miles, with whom Tinker was training, wrote Paterson to advocate for Tinker. Miles went into detail about Tinker, reiterating his age, degrees, those he had worked with, and particular areas of interest: individual differences, physical and mental hygiene, child psychology, eye movements, and work in the laboratory. He said, about research Tinker completed under his direction,

> "I am very pleased with his ability. He has shown himself able to master the technique of the eye movement recording camera and to handle alone high school and other subjects, photographing the eye movements during periods of reading. He gives minute attention to the experimental literature in the field in which he is working, and has the ability to put his own results in good shape."
> (Letter, Miles to Paterson, February 23, 1927, Tinker files, University of Minnesota Department of Psychology)

Miles then reiterated Tinker's experience at Stanford, and said he was sending copies of Tinker's published articles under separate cover.

> "On the side of cooperation with colleagues, Tinker leaves nothing to be desired. He gets on with people splendidly. Personally he is punctual, prepares his work well, and I believe makes a satisfactory impression with students. From the standpoint of scholarly interests he is quite above the average Ph. D. candidate." (ibid.)

On April 21, Paterson sent a telegram to Terman:

> "WOULD TINKER BE INTERESTED IN ASSISTANT PROFESSORSHIP AT TWENTY-SEVEN HUNDRED TAKING CHARGE OF INTRODUCTORY AND ADVANCED EXPERIMENTAL PSYCHOLOGY AND AIDING IN INTRODUCTORY COURSE HERE QUESTION IF SO PLEASE HAVE HIM WRITE LETTER OUTLING (sic) ACADEMIC AND OTHER QUALIFICATIONS FOR OUR CONSIDERATION STOP BILLS IS PROBABLY GOING TO CHICAGO TO REPLACE ROBINSON STOP HAVE TINKER WIRE REPLY COLLECT."
> (Telegram, Paterson to Terman, April 21, 1927, Tinker files, University Minnesota Department of Psychology)

Terman returned an affirmative telegram, while Tinker wrote Paterson a letter the next day.

> "I should like very much to locate at the University of Minnesota. I would rather work in contact with your stimulating group and in a well equipped laboratory at the salary you offer than to go to some less desirable place at a higher salary. I am much interested in research and writing and have planned a program which I hope to carry out during the next few years. It seems to me that Minnesota would be a most favorable place for professional growth."
> (Letter, Tinker to Paterson, April 22, 1927, University of Minnesota Department of Psychology)

Tinker again outlined his past experience, beginning, "My major interest has always been experimental psychology....". He listed names of those he has worked with, suggesting them as references. Tinker did not realize that his prior application for a fellowship produced support for his application for a professorship. In his personnel file were letters from most of those he named, recommending him as a person with good experience.

Kimball Young: "...original, ...steady and hard-working, ...pleasant, ...co-operative and thoroughly willing to work."

Boring: "...very likable, ...good scientific ideals, ..not tremendously original, ...I think he would fit into your group..." (!)

Burnham: "...excellent student,...industrious, ...broad views in education, ...a grip on essentials, ...an excellent man to work with."

Pratt: "...no reservations to make regarding his capabilities, ...unusually capable, ...a very good head and lots of serious industry..." recommended "most highly".

Sufficient detail rendered unlikely the necessity for Minnesota to again contact those with whom he worked; his letters of recommendation were already on file. While they were written for a slightly different purpose, the information they contained remained applicable.

As Tinker wrote, Terman also wrote. He reiterated the telegram he had sent indicating Tinker's interest and the support of the entire Stanford department, but he had some information on Tinker that he felt impelled to add prior to Tinker's hiring.

He began "I feel sure you will be entirely satisfied with Tinker, especially after you have known him for a few months," but seemed driven to discuss some of Tinker's personal characteristics.

"On first meeting him one may be inclined to feel that he is perhaps a little lacking in that cultivated air which is supposed to characterize the college professor. This impression is soon dissipated. What he lacks in external polish he makes up in sterling qualities of both character and intellect."

And,

"Tinker shows his good judgement in being most anxious to secure this position in preference to two or three other prospects which would pay a good deal more money. That is the sort of thing that characterizes him. He likes the things that are worthwhile."
(Letter, Terman to Paterson, April 22, 1927, Tinker files, University of Minnesota Department of Psychology)

One wonders why Terman felt a need to emphasize these factors if he truly believed that they would not prove hinderances. This was the second time Terman mentioned Tinker's lack of culture while recommending him highly.

Calvin P. Stone, a Minnesota graduate and professor at Stanford, advocated for Tinker. Coincidentally, he said,

"... when Dr. Miles and I were talking over the previous opening for which Mr. Tinker was considered at Minnesota, I suggested that the position taken by Mr. Bills last year would be exactly what Tinker was prepared to handle exceptionally well. ... whether some shift in the work might not be made so Mr. Tinker could handle more of the straight psychological laboratory work."
(Letter, Stone to Paterson, April 22, 1927, Tinker files, University of Minnesota Department of Psychology)

Stone said Tinker was "thoroughly honest, dependable and ambitious." With all the emphasis on Tinker's excellent research background while Terman cautioned as to his personal characteristics, Paterson began to wonder about other competencies.

On April 25, Paterson wrote that, while they were "favorably impressed with him", they had one concern which had not been suitably addressed in any of the enthusiastic recommendations:

"Is Tinker an able classroom teacher? ... Our department is so organized that we require and value good teaching ability and genuine research drive.

Tinker seems to have the latter beyond all question. If he has the former we would be completely satisfied."

But, as if to leave no stone unturned, Paterson asked,

"When you give me this information about Tinker would you be willing to recommend Robert Seashore as enthusiastically as you have recommended Tinker?"

(Letter, Paterson to Terman, April 25, 1927, Tinker files, University of Minnesota Department of Psychology.)

Terman had said Seashore was more highly cultured, and seemed to emphasize Tinker's lack. After all the enthusiastic letters he received about Tinker, and his own indication that an offer would be forthcoming, he invited Terman to have Seashore submit an application "if you could do so without embarrassment." (ibid.) Terman's reservations, while surrounded by praise for Tinker's abilities, stuck in Paterson's mind. He wondered if Terman truly felt Seashore would be more suitable. However, he was not adamant about this application, and added "I think that we will be ready to make Tinker a proposition as soon as we receive additional word from you." (ibid.) If Terman's reservations were significant, Paterson would now know.

On April 28, Terman wrote a letter specifying his impression of Miles Tinker. First he said that Tinker's health was good in spite of his prior stomach operation. Then he addressed his teaching:

"I am frank to say you would not find Tinker equal to Foster. Indeed I imagine that few psychologists in the country were Foster's equal in the classroom."

Why Terman compared an experienced professor who had few national peers to one still in graduate school is unknown.

"I can only say that Tinker's teaching here has been satisfactory."

In this letter, at this late date, Terman again reviewed Tinker's deficiencies:

"Perhaps one shortcoming is that he seems at first to lack somewhat in aggressiveness; a second is that he occasionally makes a linguistic error in conversation and in lecture. For this reason it is conceivable you might for the first few months wonder why we had recommended him so strongly. The reason is that we believe that his research ability and scholarly interests

are such as to insure his success in spite of these handicaps. After knowing Tinker one is able to overlook a certain lack of polish and of social vivaciousness."

About Seashore, Terman said he was:

"as good a man as Tinker in scholarly and research ability and would be rated by most people higher than Tinker in personal characteristics."

(Letter, Terman to Paterson, April 28, 1927, Tinker files, University of Minnesota Department of Psychology)

However, Terman said, Seashore was committed to his N. R. C. Fellowship for the coming year, and so would not be available. Again, one wonders why Seashore has been mentioned and discussed if he was not even available.

There is a school of thought, in letters of reference, which asserts that a writer must always say something negative about the subject so that the reader knows the evaluation is objective, since no individual is perfect and everyone has negative characteristics. It is possible Terman belonged to this school of thought. Otherwise his recommendations about Tinker made little sense unless he was concerned about others' evaluation of his judgment and, therefore, his own reputation. He obviously wanted Tinker to have the job. There was no other person Terman could suggest who was a better choice and who was also available. Tinker's appointment had appeared assured on April 21, but was held up due to this unnecessary fussing on Terman's part.

Terman apparently showed the letter he intended to mail to Calvin P. Stone who wrote an impatient addendum fiercely defending Tinker which also gives an insider's view of some prominent individuals at Minnesota:

"I feel quite confident that Mr. Tinker's ability to handle the work called for will very quickly outweigh any handicaps offered by his lack of polish and defects of language expression. One only needs to recall how uncouth Dr. Foster was in everthing except mental achievements. Yet I never once noticed Dr. Elliott or Dr. (sic) Paterson appearing ashamed of Foster.

Likewise, Dr. Lashley had many eccentricities which were apparent, yet Elliott, Paterson, and others were always ready and anxious to counterbalance these eccentricities in the minds of strangers by remarks

concerning his excellent mental qualities. In the next four or five months I believe Miles could coach Tinker on certain points that we now look upon as handicaps, and in fair measure correct them."
(Letter, Stone to Paterson, April 28, 1927, Tinker files, University of Minnesota Department of Psychology)

This insider's view of important men in psychology suggests that Stone sees no defects in Tinker which are unusual in men of achievement within college environments.

Tinker received, gratefully (as has been seen), assistance with mispronunciations from Terman. Surprising, in this trail of concern from Terman, especially since he was a specialist in children and intelligence, was his own lack of reflection upon the source of Tinker's linguistic problems.

As Tinker himself recognized, in writings to his grandchildren, his problems were predictable in anyone who suffers early deprivation of adequate educational opportunities and birth in a poor, uneducated family. Terman must have known this. Either he was not aware of Tinker's admirable achievement in overcoming his early handicaps or he was too close to recognize, objectively, the truth of Tinker's situation. Rather than viewing the difficulties as a lack, Terman should have seen them as a symptom. If Tinker could overcome his early environment to negotiate successfully all avenues to a Ph. D., he was surely capable of overcoming residual symptoms of early linguistic deficency.

This logic coupled with obvious attributes of high competence in his achievements should not only have been pointed out, it should have quickly allayed any fears of Tinker's ability to conduct himself appropriately in Minnesota. This incident illustrates that even giants of psychology did not always successfully apply scholarly knowledge to their own surroundings, in spite of training and renown in theoretical areas.

Whether due to Stone's or Terman's letter, Paterson was finally convinced. On May 3, 1927, Paterson sent a telegram to Tinker:

"PLEASE WIRE IF YOU WILL ACCEPT ONE YEAR APPOINTMENT AS ASSISTANT PROFESSOR OF PSYCHOLOGY AT TWENTY SEVEN HUNDRED STOP DETAILS OF PROGRAM CAN BEST BE WORKED OUT BY CORRESPONDENCE STOP TEACHING LOAD NOT TO BE MORE THAN TEN

HOURS PER QUARTER STOP TIME AND SUPPORT
FOR YOUR RESEARCH ASSURED."
(Telegram, Paterson to Tinker, May 3, 1927, Tinker files, University of Minnesota Department of Psychology)

This telegram was filed at 12:05 PM. At 12:55 (PM)the same day (California time), Tinker sent a return telegram, which was received at 3:20 PM.

"I GLADLY ACCEPT POSITION AS STATED
IN WIRE STOP LETTER FOLLOWING"
(ibid., Tinker to Paterson)

Tinker had no doubts about his desire to work at Minnesota. Recalling the letter Tinker received from Boring several years previously referring to Minnesota (and Stanford) as one of the "two promising places in the country" it is understandable why this decision was an easy one for him. For an ambitious young man fresh out of graduate school, this was a plum job for him, and Tinker knew it.

While Eva Tinker may have felt ill at ease in the academic environment, letters written in support of Tinker's hiring at this time indicated positive feelings about her on the part of Terman and W. R. Miles. Miles said she is a "competent, attractive person and is a great success as assistant secretary in our department. They are a well-liked couple here." (Letter, Miles to Paterson, February 23, 1927, Tinker files, University of Minnesota Department of Psychology) Even Terman said in a telegram, "Fine little wife". (Telegram, Terman to Paterson, April, 22, 1927, ibid.)

Within the next twelve years at the University of Minnesota, Miles and Eva had three children, Milton (1929), Gordon (1931) and Karen (1939). As mentioned, Boring's concern that Tinker would be distracted by marriage proved unfounded. In fact, the years of Tinker's marriage to Eva were his most productive. Eva's life revolved around her family and it is likely her support and attendance to family matters assisted in Tinker's content.

Political Beginnings at Minnesota

The hirings of Tinker and Paterson can be compared with regard to the political climate set up within the Department at Minnesota. Paterson's early authority over Elliott and his position in industry appears to have established a sense of his exceptional value. Elliott fought for a maximum salary for the priviledge of having Paterson come to Minnesota in spite of the fact that he had no Ph. D.

Elliott placed great value on Paterson, knowing his experience and dynamic strength.

By the time Paterson was hired, Elliott had been department chair for two years. When Tinker was hired he was out of the country. Paterson cagily negotiated a high salary for himself with no Ph. D. Then he negotiated a low salary for this new Stanford graduate who had completed his Ph. D. Paterson had begun in 1921 at $3600 for teaching six hours per week. Tinker was going to begin in 1927 at $2700, teaching ten hours per week. Paterson had significant influence with the department chair. If Tinker had suffered from a large ego, conflict might have ensued from the beginning. The environment was ripe for professional jealousy and intrigue

This was not to prove true. In fact, Paterson became Tinker's best friend, adding substance to an impression of Tinker as a modest man who enjoyed good relationships with his peers. Each man had his place, and each was satisfied with the position he assumed. A poor farmer's son had achieved the pinnacle of his dreams and his modesty required no greater achievement save a continuing life of research and assisting others in understanding the joys of experimental psychology. Miles Albert Tinker was a satisfied man. He had no need for jealously.

Although the original offer was for one year, one extended into 32, and the life of research that Tinker sought. While Paterson originally sought a replacement for Woodrow, and was apparently (according to Terman's early letter) not seeking an experimentalist, the coincidence of the appearance of a good candidate with an unexpected opening had created a unique opportunity for Tinker. Under "Remarks", Paterson wrote "Dr. (sic) Tinker has published five experimental papers since 1922 and has taught courses in General Psychology, Child Psychology and Experimental Psychology."
(Personnel paper prepared by Paterson, May 12, 1927, Tinker file, University of Minnesota Department of Psychology)

Within a year Tinker was advanced to full membership in the Graduate Teaching faculty (memo from Dean Fording to Tinker, dated March 13, 1928, Tinker files, University of Minnesota Department of Psychology).

In a letter to Elliott dated August 7, 1929, Paterson included as a post script:

"Tink was highly pleased with his raise."
(Letter, Paterson to Elliott, August 7, 1929, Paterson file, University of Minnesota Department of Psychology)

It is apparent that Elliott communicated his approval of the performance of his staff in a concrete way. Tinker's performance upon reaching Minnesota was apparently quite adequate. Gordon Tinker remarked that his father modestly felt he was advanced more quickly than he deserved. (Personal communication, May 1, 1988, Seattle, WA)

More likely his performance was excellent and Elliott, with or without Paterson's influence, rewarded good work appropriately. Nowhere is evidence that Elliott, Paterson, and Tinker were anything other than good friends and mutually respecting colleagues over their 30 years at the University of Minnesota.

Minnesota

Others recruited by Elliott to Minnesota in the early years were: W. S. Miller (educational psychology), J. E. Anderson (Child Welfare Institute, now the Institute of Child Development) and Florence Goodenough (persuaded to join the staff in 1924) who had trained with Thorndike at Columbia and with Terman. Goodenough had finished her doctorate at Stanford the year before Tinker began (1924). Tinker published five articles with Goodenough while she was at Minnesota. They were best of friends.

Tinker knew other people at Minnesota who later became famous (like Goodenough) within the history of psychology. During the late thirties and early forties the Tinker family lived next door to the Skinner family. Gordon Tinker babysat the Skinner children and remembers well the air crib and black box for which B. F. Skinner became famous. Gordon also remembered a segment of Walden II when he recalls his neighbors' lawn. Skinner wrote, about his ideal utopia, that the grass would be eaten by goats so it would never have to be mowed. In fact, Skinner seldom mowed his own lawn, a constant aggravation to Gordon's father, the farmer's son who took great pride in his own lawn and garden.

Gordon also remembered feeling that Skinner's boxes and automatic cribs may have been an escape from child care, because the Skinner children appeared neglected. In any case, Tinker did not agree with Skinner's philosophies, personally or professionally. (G. Tinker, personal communication, May 1, 1988, Seattle, WA)

Gordon also had special memories of growing up in the University environment. "It's not like any place else" he said, "it's very special, and it leaves a lasting influence on your whole life to grow up around people of such caliber."

He remembered his father often working late into the night. When he wanted to have a talk with him he entered his office and sat on a couch which Tinker used for afternoon naps. He waited patiently until his father finished a segment of work, at which time Tinker would turn his complete attention to his son. Gordon remembered no impatience or shortness at these times, rather that he could count on his father's willingness to have talks about matters that were important to his children. (G. Tinker, personal communication, May 1, 1988, Seattle, WA)

These early days appear stable. Tinker worked hard as his family grew. However, as Gordon entered his teens, his mother became gravely ill, as indicated in a letter from Boring to Tinker dated April 3, 1944.

> "I am sorry to hear about your wife, but pleased to hear that she is now recovering. These crises are awfully difficult things in both emotional and professional life for all of us." (Letter, Boring to Tinker, Tinker family files)

Eva was eventually found to have uterine cancer. Pap smears did not exist in the 40's. While Eva's illness may have been curable today, scientists experimenting at that time with radium as a cure for uterine cancer did not yet understand appropriate dosage levels. Instead of dying from the cancer itself, Eva died in June, 1947 from radium poisoning, the same malady as Marie Curie. (G. Tinker, personal communication, May 18, 1988, Seattle, WA) She had been married to Miles for almost exactly 22 years.

The Tinker children were approximately 18, 16 and 8 and now were without a mother. Thirteen years later Tinker reflected on his feelings at that time: "I had a bad time after Eva died after a long severe illness." (Letter, Tinker to Boring, May 17, 1950, Tinker family files.)

Relatives in Massachusetts actively sought a new wife for Tinker, the now-eligible widower. They sent him the name of a woman who was the Director of the School of Social Work at Minnesota, Katherine Howland, who had grown up 40 miles away from the Huntington farm where Tinker was born. Prior to her work at Minnesota, she had been a WAC during World War II and had spent several years in China where she assisted in refugee resettlement.

While Katherine knew Tinker had been sent her name, she did not hear from him. She had given up when he called to invite her to lunch. Miles and Katherine liked each other immediately and married within the year. Relatives in Massachusetts who had brought them together, feeling responsible for this matchmaking, were upset when the marriage took place without first notifying the family. (Personal communication, G. Tinker, May 18, 1988, Seattle, WA)

This marriage was also mentioned in Tinker's letter to Boring:

> "I married again, a year later. Katherine comes from the New England Howlands. ...It has meant a great deal to me and the children to have a complete family again." (Letter, Tinker to Boring, May 17, 1950, Tinker family files.)

Gordon remembered family life in transition from Eva, the country girl, to the worldly Katherine. Milton was grown and leaving home, Karen was still very young, but Gordon remembers changes. Aside from the expected sorrow and adjustment to the loss of a loved one, the Tinker children adapted to their new mother. Katherine's knowledge of children and social difficulties may have included a special understanding of the adjustments the children had to make. (ibid.) Katherine had a career, and so a housekeeper, Mrs. Speaker, was hired full time to do the housework and house sit during summers when the family went to Massachusetts. The dinner hour was changed from 5 to 6 PM to allow Katherine time to get home. If the children were not there, they simply missed dinner rather than having it saved, as Eva had done.

Unfortunately the times dictated an anti-nepotistic rule that a married couple could not both work for the University of Minnesota. While this rule was changed shortly thereafter, Katherine was forced to resign her job in order to marry Miles, and began work at a private clinic as a social worker. (Personal communication, G. Tinker, May 18, 1988, Seattle, WA)

Gordon says Katherine Tinker fit comfortably into academic life. For Miles and Katherine, mutual understanding of Massachusetts culture and common interest in Massachusetts summers, must have added understanding to this second marriage. (ibid.)

Summers in Massachusetts were intellectually busy times for Tinker. He had friends with whom he spent time sharing literature and ideas for more experiments. One of his best friends, a man named Putnam Cross, ran the local pharmacy and enjoyed

philosophy. Every summer "Put" (like Tut) and "Tink" exchanged books and discussed what they had read in the year they had been apart. Put was 10 years older than Tink, but had been his contemporary at Clark. They were lifetime friends, intellectually and personally. Gordon remembers receiving books from Put at Christmas time. (ibid.)

Tinker had a couple of other friends in Massachusetts whom he saw in the summers, one an electrical engineer named George Sheaver and the other a mechanical engineer of considerable note, named Jim Ryan. Ryan was an inventor who was involved in development of flight recorders and seat belts. Gordon said that a museum exists containing Ryan's work. Ryan's son recieved a Ph. D. from Minnesota. (ibid.) It is easy to imagine these men concocting apparatuses and discussing appropriate levels of illumination, inventing experiments which Tinker would try out in the coming academic year. Tinker appeared to have taken advantage of resources, for intellectual expansion, that he found in his environment. Summers must have been a special time for the Tinker family.

Historical Recursivity

When Tinker began work at Minnesota, the past experiences and acquaintances began recurring. One of the first tasks Tinker undertook after arriving at the University of Minnesota was a revision of Foster's Experiments in Psychology (Foster, 1923, Foster & Tinker, 1929). Foster had died unexpectedly in 1925. A dedication to E. B. Titchener stems from Foster's training at Cornell and his dedication to Titchenerian methods. Boring re-entered Tinker's life, since he had reviewed and criticized the first edition of this book. Foster and Boring were both Titchener's students. Tinker was Boring's student (and almost Titchener's), and worked at the institution (University of Minnesota) where he became a co-author with Foster. Tinker appeared to be a perfect choice for revising this book, particularly with the addition of his fresh Stanford view. At this same time, Tinker and Paterson began their typographical studies which would continue for thirty years.

The early history of psychology and this story appear as a web of interlocking relationships and recurring names. Foster and Boring both trained with Titchener. Foster went to Minnesota while Boring went to Clark where Tinker was his student. Terman had also trained at Clark, from whence he moved to Stanford. Tinker went to

Stanford to train with Terman (and Miles), then to Minnesota where he revised a book written by Foster (1929) which had received editing assistance from Boring. Boring went to Harvard where the Minnesota Department of Psychology Chair Elliott had received his training. Elliott had met the man who hired Tinker, Donald Paterson, in the Army during World War I when Paterson was Elliott's commanding officer. Others who were part of the fraternity of World War I psychologists and figured prominently in this story were Yerkes, Terman, and Boring.

Tinker's mentor, W. R. Miles, trained in Iowa as did Robert Seashore, Tinker's competition for the Minnesota job. Fortunately for Tinker, he was engaged in an N. R. C. grant, a grant from an organization in which both Elliott's mentor Yerkes and later Tinker's mentor Miles were involved. Another aside to this recursivity was that the "Dr. Catharine Cox", of whom Terman had held such a high opinion in his initial response to Paterson's inquiry about a candidate for the Minnesota position, married Walter R. Miles, the man with whom Tinker trained at Stanford. One is reminded of hill people, where everyone is related to everyone else.

Like a family tree of the first American immigrants, succeeding generations become more difficult to map, both for reasons of mobility and numbers. These early interrelationships intrigued Tinker, who completed a paper on Wundt's doctoral students (1932). He was himself a "descendent" in that web of interrelationships.

When Tinker and Paterson began co-publishing, in 1928, their first articles on typography for the Journal of Applied Psychology, it was at that time edited by Carl Murchison of Clark University. That journal had been edited by Titchener and would be edited by Paterson. G. Stanley Hall's contribution of long ago continues today.

Summary

Review of the Zeitgeist formed by Great Persons at this time in the history of American psychology lends understanding to the environment within which these men worked. Review of Tinker's early life demonstrates the true scope of the university environment.

This story, of Tinker, Paterson, Elliott, family, and Minnesota has established the environment within which these men worked. Certain things have been verified. First, Tinker and Paterson were both well thought of both personally and professionally. Second, each was well trained and well experienced for embarking on the research

avenue of his choice. Fortunately for the purposes of this work, they chose to study the effects of typography on readers.

Prior to his work with Tinker, Paterson had spent 14 years publishing articles on statistical measurements of intelligence and performance. He was a specialist in testing. One aspect of Paterson's interest in typography, when he realized the potential of Tinker's work, may have stemmed from being the son of deaf parents and therefore part of deaf culture. A stereotypical occupation for deaf men has historically been that of printer.

In place, at this point, is one man who specialized in experimentation forming an alliance with another who was an applied psychologist. Both were thoroughly prepared to conduct investigations. Their ability to pursue their work was supported and expedited by an enthusiastic and progressive department chair who had connections with a major publisher.

While in their time the benefits of this specialized work in typography could only be directly utilized by a few people, today a new audience exists, creating a new demand for re-analysis of Tinker's and Paterson's work which can make a contribution today. Chapter 4 will review the beginning of 32 years of research on typography, with the subject of the next chapter (Chapter 3), Donald Paterson.

CHAPTER 3

Paterson

When he began working at the University of Minnesota, Tinker's life with Donald Paterson began, resulting in a new focus for his work. When asked why his father continued investigating typographical factors of print for over 30 years when, a) it was not a topic of great popularity, and b) did not bring him significant recognition, Gordon Tinker responded "because of Donald Paterson" (Personal communication, G. Tinker, May 1, 1988, Seattle, WA) As Elliott noted "what (Paterson) gets back of, goes." (Letter, Elliott to English, June 18, 1937, Paterson file, University of Minnesota Department of Psychology)

This partnership between Tinker and Paterson was a key factor in the development of 32 years of research on typography. Tinker was a quiet man who enjoyed positive interactions with others and whose professional focus was unquestionably experimental psychology. As in his earlier history, he appeared happy to accept cues from others in his environment, especially if those cues would promote his primary interest, research on visual perception. He was not a controversial man. Gordon described him as "very conservative". He was quiet, hard-working, orderly, and methodical.

When he chose to retire at age 65, letters written by ex-students arrived from all over the country. They repeatedly alluded to his encouragement, modesty, and lasting contributions in the areas of history of psychology and experimental lab work. Patience appeared more often than any other descriptive characteristic.

Paterson was the opposite personality. Aggressively "for" students, he was not a quiet man. He was a promoter. Karen Tinker Strelitz remembers him as an extroverted Irishman who loved life, people, and socializing at parties. (Personal communication, Karen Tinker Strelitz, June 25, 1988)

At the end of his career, at age 68, Paterson, like Elliott, retired most reluctantly. He thrived on his work. In 1989 he still holds the record at Minnesota for having the highest number of doctoral students pass through his mentorship, in spite of his own lack of a Ph. D. In a survey of 1,350 psychologists completed by Ken Clark (1957), Paterson was ranked fourth after Sigmund Freud, Gardner Murphy, and L. L. Thurstone as the person who had exerted the most influence in attracting entrants to psychology or affecting the nature of their

career. Listed after were such names as Terman, Hull, Woodworth, James, Seashore, Boring, and Thorndike.

Paterson and Tinker were the best of friends. The closest description of their publishing relationship must be "symbiotic". Each had his role and each fulfilled it. Beginning in 1928, they investigated every aspect of typography they could think of. With his enthusiasm for application, Paterson saw immediately the applicability of typography. It related not only to education, but also to business and industry. Elliott observed (1937) that Paterson's entire attitude toward education was determined by need. Typography made sense. What conditions does a reader need to read most efficiently? The most obvious first task in reading was dealing with typography. Paterson's work revolved around service. Study of typography served not only learners/readers, but also the industrial complex of which he was so fond.

The logic of studying typography must have been very clear to him, as it was to Tinker. Tinker continued to study typography as a part of his total approach to the study of reading, with and without Paterson. Service to both education and the printing industry satisfied both men. An argument might be made for the typographical studies as being the domain of either man. Tinker focused on legibility prior to his association with Paterson, but did not focus on typography specifically until they began co-authoring. Paterson did no studies on typography prior to his co-authorship with Tinker, but was solidly involved with concerns of business, industry, and individual needs. Once begun, Tinker continued to conduct studies on typography and related conditions, both with and without Paterson. This was the focus of his research career.

Paterson was a man of such diverse interests that his persistant co-authorship of studies involving type from 1928 to 1955, a period covering all but five years of their overlapping tenures at University of Minnesota, indicated that he felt this was an important topic. With Tinker pursuing the topic, continuity was maintained. In the literature, Tinker has survived as the researcher of typographical factors, while Paterson is seldom mentioned.

Records of Paterson's accomplishments emphasized applied psychology in guidance, business, and occupations. Often his work with Tinker was not mentioned in overall retrospectives on his career by co-workers. (Paterson files, University of Minnesota Department of Psychology)

Paterson and Tinker appeared as catalysts for each other. Tinker had all the right credentials. He had studied at the premier institutions with top people in psychology and had a Ph. D. from Stanford. Paterson, on the other hand, never received an earned doctorate, but had studied with top people, had clearly demonstrated his competence, and was highly prized by Elliott. He carried great power and influence in the Minnesota department. His work with Pintner and years as a World War I psychological examiner and enthusiasm for test construction rendered him highly qualified for his work.

Paterson's involvement in psychology included his years as Secretary of the American Psychological Association (APA) and Editor of The Journal of Applied Psychology. His own credentials were excellent, but there is evidence that he had to fight, throughout his life, the stigma of not having a Ph. D.

Understanding Paterson's approach gives an indication of why Tinker's work evolved as it did – with emphasis on application instead of theory, which may have resulted from co-authorship with another scholar. The conditions of Paterson's life are illustrated through a particular incident which occurred at the height of Paterson's career.

Immediately prior to this incident, Elliott wrote a letter which revealed both insights into Paterson the man and Elliott's high esteem of his colleague. The purpose of his letter was recommendation of Paterson for the position of Chairman of the department of educational psychology at Ohio State University, Pat's alma mater. This letter is recorded in its entirety for purposes of history and its characterization of Paterson via Elliot's view of him. It is addressed to Dr. Horace B. English and dated June 18, 1937:

"Dear Horace:

> I could almost reply by telegraph to your letter of June 12 inquiring about Paterson's qualifications for the chairmanship of a university department of psychology. He is not a man who must be written about in carefully picked words. I was with him in the Army and have served shoulder to shoulder with him here for sixteen years and I know him inside and out as just one hundred percent. Any job he tackles will be in the hands of an exceedingly able man. He is a born promoter, and what he gets back of, goes. He is, as you know, the

ardent advocate of what we used to call applied psychology. Perhaps technological psychology, and psychometrics are the best labels for it now.

Paterson has been the backbone of the personnel program at Minnesota and it is largely because of his work that our university has done relatively so much in the diagnosis of student aptitudes and in student counselling. Paterson's interest in this field definitely colors his attitude toward psychology in general. He sees psychology, and every other department of instruction, as a service enterprise. He looks at society and asks what functions we psychologists can train students to fulfill and the answer determines, for him, the ideal curriculum. If there were a dozen Patersons in the country, there would be fewer unemployed Ph. D.'s in the country. He holds the same attitude toward education in general that he holds toward his own subject. Just as in Psychology he is not shut up in a laboratory, so he is no cloistered academic professor. He serves on a very large number of national committees and is constantly approached with the suggestion that he forsake university life for a position in New York or Washington, where he would promote some nation-wide movement in testing or occupational guidance or the like.

Paterson likes action, and is impatient with obstruction. He works hard and all the time and he wants others to do the same. He will be an ideal head of a department, especially with a liberal budget at his disposal and a good steady assistant to care for administrative details. The question has often been raised on this campus, and even within the department, which of us, Paterson or myself, is the real chairman of the department. Speaking for myself, I'm gratified that nobody has a clear answer to that question.

It would be foolish for me to write you about Paterson's productivity. His bibliography has no padding and no frills, and no vagueness about it. It will win him the A.P.A. presidency before long.

So you see I think Pat's Alma Mater ought to offer him the job. But I warn you that Minnesota won't let him go without a struggle.

I'm looking forward to seeing you here the week before Labor Day.

Sincerely yours,
R. M. Elliott

(Paterson file, University of Minnesota Department of Psychology)

Elliott does not appear to be describing a man on the verge of a breakdown.

Crisis

In September of 1937 Paterson had a breakdown at the APA meeting which met in Minneapolis. It is not known exactly what happened. He resigned his position as A. P. A. Secretary, recommending that the duties of that position be perhaps split and pared down to a manageable level. He was forced to give up many of his activities until he recovered, a period extending for over a year.

In December of 1938, Elliott wrote letters of apology to Terman and others to whom Paterson had made commitments. In his letter to Terman, Elliott said,

"Pat has never really been on his toes since his breakdown following the Business Meeting at the Minneapolis meeting of the A. P. A. a year ago".
(Paterson files, University of Minnesota Department of Psychology)

To James Van Toor of Farrar and Rinehart (publishers), on January 21, 1939:

"Early in December it was decided by everybody who knew Pat that he must be given a release from all heavy duties for as long as he desired. His nerves were pretty well shot and we all saw that we were doing a year late what we should have done when he originally "collapsed" during the A. P. A. sessions on this campus a year ago last September." (ibid.)

Elliott demonstrated concern and strength as department Chair by actively working out a solution to help a valued and valuable person recover from personal difficulty. He knew this man and had complete confidence that Paterson would recover. He wrote Van Toor to request a release for "Pat" from a book contract he had signed over a year earlier.

"The doctor put it up to me to see if it would not be possible to secure a release from the obligation. I went to Pat with the idea on the same day that he learned from his doctor that he must resign from his 1939 summer session appointment at Stanford. I think it was on that day that Pat hit the low point in calling himself "no good." So I decided to let things run along for the present about the book but all the while that (sic) we would never get Pat back to his old pep unless he could be persuaded to start with a pretty blank slate and then write on it the agenda for a given week, or year, in proportion as he felt himself regaining the ground he had been losing pretty steadily since the September, 1937, crisis. (ibid.)

Elliott said he did not believe Pat was capable of writing a book by himself at that time.

"My prediction is that there is not much chance that Pat will undertake a book of any kind, except the completion of the four-fifths written book on typography, within the next five years." (ibid.)

Tinker carried the load during his friend and colleague's crisis period, enabling How to Make Type Readable (1940) to come to completion in spite of Paterson's difficulties. Tinker and Paterson published no typographical studies in 1937. Elliott ended:

"Fortunately, I can report that the first lightened schedule that Pat had ever allowed himself to accept is having its good effects and we have no doubt at all that providing he continues to decline three-fourths of the requests that people make him for one or another kind of service, he will be himself one-hundred percent again by September, 1940." (ibid.)

He then added a P. S.:

"Lightened load means absolutely no classes and only an occasional conference with a student. The rest of the time Pat is at his carpenter's work bench and skating." (ibid.)

In January, 1941 a "Cumulative Record of the Faculty" lists Paterson's activities as: Secretary of APA, President of the American Association for Applied Psychology, President of the Minnesota chapter of Sigma Xi, and President of the Minnesota Society for Applied Psychology. Under "leaves of absence" was typed "none".

Elliott had apparently saved his friend and colleague from professional burn-out and simultaneously showed his considerable personal strength as Chair of the Department of Psychology. (ibid.)

The cause of Paterson's breakdown (if there was one cause) is subject to speculation. From his list of activities, he may have been trying to do too much, but the letter from Elliott did not indicate this as a problem.

In June, 1937, Ohio State University, Paterson's alma mater, was considering him for Chair of their department of psychology. It was a mere three months later that he had a breakdown. That Paterson's breakdown was a reaction to being passed over for Chair of the Ohio State department is a matter of speculation, but the timing between that consideration and his breakdown is coincidental. Presumably if Paterson had been offered the position he would have taken it. His brother (ten years his senior) was a professor at Ohio State University. He did not leave Minnesota.

Lack of a Ph. D. would have been a strong yet simplistic reason for his not getting the job. He was a man with strong ties to Ohio, and this would have seemed the opportunity of a lifetime for him. If his heart was set on that job and the simple lack of a Ph. D. precluded his hiring, this would have been devastating. Not only would it have been wrong, to Paterson, with regard to the position, but also to his whole philosophy of the importance individuals have in productive life, particularly within student service professions. He was a man who felt that need should dictate choice. His qualifications should not have held him back. Except for the Ph. D.

The incident may also have had the effect of letting him know how restricted were his options without the terminal degree (Ph. D.) which by now was too late, professionally, to obtain. It would have been absurd at this point, for a full professor with 16 years of supervising Master's and Doctoral students to return to school for his own doctorate. This would not be the last time he was confronted with this personally sticky issue.

Ten years later George Kelly, Director of the Psychological Clinic at Ohio State University wrote Elliott to promote the Ph. D. as a minimum standard for psychologists. His comments may reveal the attitude of Ohio State toward minimum standards for those in the field of psychology:

> "It has come to my attention that representatives of the U. S. Civil Service Commission and individual members of the recently appointed Board

> of Expert Examiners have been reluctant to recognize the Ph. D. as a minimum standard for psychologists employed in responsible positions by the Government. ...now, during this post-war period ... is the time to associate the psychological profession with a definite academic standard.
>
> ... I hope that the A. P. A. Board of Directors will express vigorous support for the establishment of the Ph. D. as a minimum standard for psychologists employed by the Government at fully professional levels. ... This letter, written as an individual expression of interest, is to urge you and the other members of the Board to provide Doctor Wolfle with a clear expression of your group opinion at the earliest possible moment." (Letter, Kelly to Elliott, March 18, 1947, Paterson files, University of Minnesota Department of Psychology)

In his response to Elliot on this issue, Paterson expressed his attitude, not only on the role of the Ph. D. in relation to Kelly's ideas, but to the role of training and degrees for specific jobs in psychology. In this response, Paterson wrote as if he were an instructional technologist, fitting the training to the task, rather than arbitrarily setting criteria which offer no real solution. This letter also gives insight into Paterson's philosophy toward psychology, as he responds to this letter as a professional.

> "I find myself in agreement with Dr. George A. Kelly's desire to see the United States Civil Service Commission and its Board of Expert Examiners appoint the best qualified psychologists possible for responsible government positions which are primarily psychological in character. However, I believe he has an unrealistic view of the present situation.
>
> If the Ph. D. were required as a mimimum (sic) standard, hundreds of well-qualified professional psychologists (Lloyd Lofquist for one) would be barred from the merit examination. It would also admit hundreds of Ph. D.'s who are not qualified in the sense of being prepared by the nature of their training or by being prepared in terms of quality (think of Ph. D.'s in Educational Psychology you know) to assume responsible positions." (ibid.)

Paterson might have included himself among those who would have been barred from the merit examination. The fact that this letter arrived from Ohio State, Paterson's alma mater, carried particular irony. Paterson supported his views with evidence from the psychological literature, and pointed out:

> "There are probably many M. A.'s in psychology and many M. A.'s and Ph. D.'s in allied disciplines (political science, sociology, educational psychology, industrial relations, etc.) who are far better qualified than many poorly trained or wrongly trained Ph. D.'s in psychology. I believe we do a dis-service to psychology as a profession to attempt to put the stamp of approval on "Ph. D.'s in psychology" only at the present time." (ibid.)

It is safe to assume that Paterson felt that he himself was perfectly qualified as a psychologist to carry out his duties, a fact supported at all times by Elliott.

In a letter to Elliott in December of 1947, Paterson responded to reading Harvard University's "The Place of Psychology in an Ideal University," expressing his gratitude for Elliott's vision and support as department Chair. Paterson also reflected on Elliott's web of scholastic interrelationships, similar to Tinker's, which resulted in tradition passing to those who came after.

> "As the report stands it seems to be a remarkable tribute to your sagacity and foresight when you began, in 1919, to build a department around the objectives now enunciated by the Harvard Committee. Without detracting from your contribution I suspect you owe a great deal to the depth and breadth of the professors of philosophy, psychology, and psychiatry at Harvard in the golden days when you were a student there and when Holt, Perry, Santayana, Southard, Wells, Muensterberg (sic), and Yerkes were the leaders.
>
> I suspect that you have really profited most, however, throughout the years from your continued fruitful association with Yerkes, who deserves to be acclaimed as psychology's greatest statesman. You have been a faithful disciple and Minnesota has reaped the benefits." (ibid.)

Paterson reflected on the Ph. D. vs. M. A. issue once again, this time reflecting also on his own situation:

> "The report is another instance of "cultural lag" in psychology. I was glad to note that Hilgard (p. 32) recognizes the importance of the policy you have always upheld, namely, liberalizing the Ph. D. to make the requirements appropriate to the purposes of the candidate in training. I shudder to think about what I and some of my Ph. D. candidates would have done without your constant recognition of this principle. And for this I am grateful." (ibid.)

In a one-sentence paragraph, Paterson made a summary statement of his own philosophy, both personally and professionally:

> "The only topic the Report overlooked appears to be the terminal M.A. degree for those who can perform worthwhile psychological needs of present-day society." (ibid.)

The loneliness of this paragraph and its appearance 26 years after beginning his work at Minnesota, 23 as full professor with an M. A., imply a pain about its message.

Paterson fought to justify the role of the M. A. all his life. Presumably he would have retained this view even if he had himself possessed a Ph. D., but the fact that he did not made it an even more personal issue. It would have been ludicrous for Paterson to have gone back to school to finish his degree after attaining full professorship and assisting so many others in this quest. Elliott and the Department of Psychology at the University of Minnesota found nothing lacking in his ability to direct approximately 300 Master's theses and 88 Ph. D. theses, no matter what his degree.

On June 17, 1952, the new department Chair at Minnesota, Paul Meehl, wrote to Howard L. Bevis, president of Ohio State University to investigate the possibility of an honorary degree, "probably most appropriately a D. Sc.", for Paterson:

> "It is his name more than any other which the profession associates with the high prestige of the Minnesota department. He is recognized not only in America but over the whole world as one of the prime movers in the growth of scientific vocational guidance.
>
> A long list of publications, of "Minnesota"-built tests, and of top-flight Ph. D.'s attest to his capabilities. (It has always struck our staff as paradoxical that

> Paterson leads all the rest of us in the number of "doctors" he has advised, but is not thus titled himself!)
>
> He is one of the rather restricted number of scholars in the field of psychology who have been honored by election to the National Academy of Science. He was one of the founders of the American Association for Applied Psychology, which had such a great role to play in the expression of the "useful" tradition in American psychology.
>
> With the late J. B. Johnston he helped to develop the Minnesota system of student personnel work which has been a model and inspiration to American universities over the years. For the past few years he has been editor of the Journal of Applied Psychology." (Paterson files, University of Minnesota Department of Psychology)

Paterson was awarded the L. L. D. by Ohio State University in 1952.

One important aspect of Tinker's and Paterson's professional relationship on this issue was mutual respect. Because Tinker had the Ph. D. degree, and from Stanford, Paterson might have become defensive, but he did not. Tinker gave him no reason. If his self-concept had revolved around his Ph. D., Tinker might have resented Paterson's strong personality, but it is apparent that he did not. While other men might have engaged in a power struggle, Tinker and Paterson did not. They recognized each other's strengths and accepted them as they were. They liked each other. Tinker accepted and enjoyed Paterson's strong personality, regardless of degree, serving as support for both him and Elliott in his quiet, stable way throughout his thirty-two Minnesota years. While not directly involved in the research, Elliott's influence comes through as a man who selected good people, placed them in positions appropriate to their talents, and encouraged them to do their best work. The three men were a powerful team, lending valuable support to each other in times of need.

The next chapter will begin reviewing the product of Tinker and Paterson's partnership.

CHAPTER 4

Typographical Research

Although an extensive search was conducted in an effort to establish a reason for Tinker's interest in printing or typography, the only suggestions of this influence were his part-time jobs at the Clark University bookstore and with the Strathmore Paper Company while he worked his way through school. No evidence has been found that either of these positions had any long-term influence with regard to knowledge of or experience with type.

Tinker's interests centered on research beginning with his earliest days with Sanford at Clark. His first publications, pre-Stanford University, were "A Study of the Relation of Distracted Motor Performance to Performance in an Intelligence Test" (1922), and "A Preliminary Study of the Psychology of Mathematical Adjustment" (1923). His first publication which indicated an interest along later research lines was "Reading Reactions for Mathematical Formulae" (1926) in which he first studied eye movements, published after he had begun his doctoral work with Miles. In 1927 he published "Legibility and Eye Movements in Reading," a beginning of his life's work, based on his dissertation.

After finishing his doctorate and beginning his work at Minnesota, Tinker's first article with Paterson appeared in the 1928 Journal of Applied Psychology under the title "Influence of Type Form on Speed of Reading". There was no indication that this first study was the beginning of a series of typographical studies which eventually numbered thirteen.

The logic of Tinker and Paterson's approach to typographical research was quite simple. While they viewed their work as study of reading, it will be interpreted here in terms of the Zone of Optimal Typography, a concept within which Tinker's work can be structured.

While an argument for Tinker's work as study of reading per se would experience difficulty, argument for the importance of his work as a significant part of the reading process fares well. Certainly it fits into present pursuits of understanding imagery in cognitive psychology. We see clearly in Tinker's work that performance can be significantly influenced by changes in the imagery presented to subjects regardless of message content. Explanation for these changes in processing of imagery remains incomplete.

Print is imagery which is translated by readers into understandable concepts. Perception of imagery is requisite to processing its message. Aside from clarity of the image itself, illumination is an associated factor in its perception. Tinker observed the immediate reaction of the reader by monitoring his/her eye movements. Gauging speed of reading revealed speed of perception when comprehension was eliminated as a mediating factor. Tinker was not interested in comprehension, but simply how fast (or slow) the reader was able to recognize and process the visual image itself. If he had retained comprehension as a factor, his studies would have been confounded.

Comprehension was factored out through use of the Cook-Chapman Speed of Reading Test. This test required readers to cross out a single word which did not make sense in the context of two consecutive sentences. Tinker and Paterson found comprehension was 99.7% accurate, so they reasoned that content had not proven challenging. Any changes in perception time could then be attributed to visual processing complexity, not to content difficulties. While eye movement studies revealed early that eyes reacted to reading material with fixations (stopping at specific points) and saccades (movements of eyes from point to point), this behavior was found to be resistant to change (Tinker, 1958). Tinker and Paterson did not focus their efforts in that direction. They looked for print imagery which suited the needs of the reader.

Reading takes place in chunks; not by perception of individual letters, and Tinker realized this. He did not feel that this demonstrated the true character of reading, and he abandoned the study of individual letters early on. Paterson never studied eye movements except in co-authorship with Tinker, when the subject was typography.

Speed of reading was the measure of choice from the beginning. Tinker saw an interaction between eye movements and legibility which intrigued him, prior to his arrival at Minnesota. His love for apparatuses fit well with this interest.

Tinker and Paterson attempted to see into the reader's mind by setting up varying conditions and monitoring reader response. Rather than conducting a conditioning procedure to try to change the reader, typical of behavioral research, they asked "What does the reader need in order to perform optimally?" This was a typical Paterson question. To paraphrase Elliott, the answer to that question

determined, for Paterson, how typographical factors should be arranged. This ressembles a cognitive approach more than a behavioral one, the first sign of these researchers going against the Zeitgeist of their times. Although it was monitored, the goal was not to change behavior, but to establish under what conditions behavior (processing of typographical imagery) was optimal.

Tinker and Paterson's assumption was that those factors which encumbered (slowed) readers least were therefore those factors which allowed quickest processing of the reading image. They did not concern themselves with comprehension nor were they concerned with interpretation of reading material. They wanted to make sure that the reader had sufficiently understood information, but their interest in comprehension stopped there. Their main concerns were: "How can we present optimal conditions for the reader?" "What conditions allow him/her to read faster?" "What conditions slow him/her down?" In order to study conditions of reading, Tinker and Paterson broke those conditions down for individual study.

Review of the original thirteen studies is appropriate for several reasons. First, it gives a perspective on germinal research in a specific area, with methodological adjustments shown as an appropriate part of any new line of inquiry. Tinker and Paterson explained, as the investigations developed, the reasons for various choices and changes in approach. Reflected in these studies is response to criticisms by the academic community to this new line of research.

Second, this series provides a model for others who are developing original research on typography, along with an explanation of certain choices that had to be made in the developmental process. It allows us to reflect upon days when our present methodology was developing and understand how these methods came to be.

Third, these studies extended over eight years and bear similarity to developing methodology in study of the design of computer screens. They may offer guidance to study of typographical factors in this new medium. Tinker and Paterson's methodology, with and without Paterson's co-authorship, was based on this original set of studies.

The Original Thirteen Studies, 1928-1936

Tinker and Paterson published this series in the Journal of Applied Psychology from 1928 to 1936, entitled "Studies of

Typographical Factors Influencing Speed of Reading." The first article in the series, "The influence of type form on speed of reading," did not appear as the beginning of a series. The second article, "Size of type," was subtitled under the heading "Studies of Typographical Factors Influencing Speed of Reading," a heading used throughout the rest of the thirteen-part series.

I. Influence of Type Form on Speed of Reading

This series was initially based on the work of Daniel Starch (1914, 1923), who was interested in use of type for advertising purposes. (He co-authored an article with Tinker's mentor, W. R. Miles, in 1928.) Starch had found indications that lower case type might be easier to read than either all capitals or italics. Tinker and Paterson decided to tighten methodology and seek more conclusive answers. The "Chapman-Cook Speed of Reading Test" had been developed since Starch's original study. This test had "A" and "B" sections which Tinker and Paterson tested, finding that "B" was slightly more difficult than "A", to counteract the effect of practice. 80 students were tested in each of eight groups (640 total) :

Group I.	Form A, all capitals,	Form B, lower case
Group II.	Form B, all capitals,	Form A, lower case
Group III.	Form A, lower case,	Form B, all capitals
Group IV.	Form B, lower case,	Form A, all capitals
Group V.	Form A, italics,	Form B, lower case
Group VI.	Form B, italics,	Form A, lower case
Group VII.	Form A, lower case,	Form B, italics
Group VIII.	Form B, lower case,	Form A, italics

(refer to Appendix D for examples)

"Lower case" included capitals where appropriate (names, beginnings of sentences, etc.), as did "italics". The time limit for the test was reduced from 2-1/2 minutes (for elementary students) to 1-3/4 minutes for university sophomores. Accuracy was checked by asking students to cross out an inappropriate word in the second half of each two sentence pairs. Students were successful at a 99.7 percent accuracy level, so scoring was based on the total number of paragraphs read. Tinker and Paterson's subjects read lower case text faster than all capitals and faster than italic lettering. All capitals slowed readers the most.

II. Size of Type

In their second study, Tinker and Paterson clarified some methodological requirements:

1) a large sample for validity,
2) constancy in difficulty of text material through use of a standardized test,
3) a slightly more difficult second part to offset the effect of practice,
4) an objective check on comprehension,
5) text in which vocabulary is kept simple so that comprehension plays a minor role in processing,
6) test reliability of greater than +0.40.

The Chapman-Cook test fulfilled all requirements. In tests of 2260 Twin City (Minneapolis-St. Paul) high school seniors, correlation between the two test forms was +.76, +-0.006. This test was conducted with 320 sophomore general psychology students divided into groups of 80 each. Form A was set in 10 point type, while matching Form B's were set in 6, 8, 12, and 14 point type.

Line length was 80 mm for all size type. 10 point type was read 5.2 to 6.9 percent faster than any of the other types used. The authors pointed out that while 6 and 8 point type may have saved space, and therefore printing costs, choice of those did not support reading efficiency, slowing it down.

III. Length of Line

The third investigation studied the effect of line length on reading speed. The Chapman-Cook test was used again. Form A, with 80 mm length, was compared with Form B which was printed with 59, 97, 114, 136, 152, 168, and 186 mm line lengths. All type was set 10 pt. The study was conducted with 560 college sophomore psychology students. 80 mm line length yielded the fastest results compared with the others studied. The next closest, and only non-significantly different line length was 97 mm. Tinker and Paterson reflected upon other recommendations in the literature and concluded that optimals ranged from 75 to 90 mm. Presumably, 97 mm would also be acceptable.

A surprising aspect of this study was discussion of an aptitude-treatment interaction. The authors noted that when they looked at line length in relation to reading speed, extreme variations in line length appeared to disturb faster readers considerably more than slower readers. One explanation was that rapid finding of the next line may prove more difficult with long lines which would not disturb those who were slow at finding the next line anyway.

IV. Effect of Practice on Equivalence of Test Forms

Experiment number four was partly a response to criticism, and sought to verify the equivalence of Forms A and B of the Chapman-Cook Speed of Reading Test. Tinker and Paterson pointed out that the validity of their studies was based on an assumption of equivalence. Equivalence was previously established by using an ABBA sequence in the first study. However, when using control groups in a later study, equivalence was not found. Form B was found to be more difficult than Form A. In reviewing scores from past testing, previous average scores on Form A were found to be equivalent to past and present scores on Form B.

The authors decided that some uncontrolled factor was causing higher scores on the later tests. The hypothesis was tested that re-taking the test upsets the equivalence of scores.
First time test-takers in Tinker and Paterson's experiments had identical mean scores on Forms A & B, while repeat test-takers did not. They explained that there was an inherent strangeness in taking any test for the first time and suggested that this may hold true for any repetition in test situations. From this point on in their studies, Tinker and Paterson used only first time test-takers in their studies.

V. Simultaneous Variation of Type Size and Line Length

The next study looked at the effect of simultaneously varying type size and line length. They used the optimal (according to their prior studies) 10 pt. type and 80 mm line length (which they now recognized according to the printer's term, 19 picas). All type was "set solid", which meant there was no extra leading, or white space, between lines. There were five groups, set as follows:

Group I.	Form A, 10 pt., 19 picas,	Form B, 6 pt., 16 picas
Group II.	Form A, 10 pt., 19 picas,	Form B, 8 pt., 17 picas
Group III.	Form A, 10 pt., 19 picas,	Form B, 10 pt., 19 picas
Group IV.	Form A, 10 pt., 19 picas,	Form B, 12 pt., 23 picas
Group V.	Form A, 10 pt., 19 picas,	Form B, 14 pt., 27 picas

(see Appendix D)

Subjects were 400 students in Engineering Freshman English classes at University of Minnesota. None of these students had taken the test before. Other specifications followed discussions on prior testing. Results suggested that maintenance of proportion between type size and line length assist reading rate. There was no significant difference between type set 10 pt., 17 picas and, especially, 8 pt., 17

picas, There were relatively minor differences for all save type set 6 pt., 16 picas. Tinker and Paterson felt that maintenance of proportion allowed the reader to obtain maximum aid from peripheral cues, and that balance may have been more important than any other single factor.

VI. Black Type Versus White Type

Two hundred eighty subjects read materials in two conditions. One group acted as control, reading the traditional black on white, while the other read white type on a black background. The control (black on white) group read materials approximately 10.5 per cent faster than the experimental (white on black) group. Tinker and Paterson saw this difference as partially attributable to past experience and to a difference in figure/ground identification. They pointed out that for purposes of advertising art, when designers wished to attract attention and were not concerned with reading speed, white print on a black background may be an appropriate choice.

VII. Variations in Color of Print and Background

An increase in the use of color in printing brought an increased interest in the effect of color on speed of reading. Luckiesh (1923) had already done a study on color seen from a distance. Tinker and Paterson selected seven of Luckiesh's most visible (4) and least visible (3) color combinations for further tests, and added three more combinations. 850 subjects, 85 per group, were tested, again with the Chapman-Cook test. They found the following to provide good legibility: black on white, grass green on white, lustre blue on white, and black on yellow. Fair legibility included: tulip red on yellow and tulip red on white. Those combinations with poorly legibility are: grass green on red, chromium orange on white, tulip red on green and black on purple. Basically, the higher the contrast, the higher the legibility.

VIII. Space Between Lines or Leading

Leading was the next subject of study. In order to provide more experience with leading variation, the authors rearranged the Chapman-Cook into one continuous passage rather than the five paragraphs into which it was previously separated, and varied "point size" (pt.). Otherwise procedures were as before. Control groups were used to maintain a check on equivalence of Forms A & B .

Tested were layouts set solid (no extra white space), and 1 pt., 2 pt., and 4 pt. leading. Subjects were 400 college students, 100 in each group. 2 and 4 pt. leading were found to enhance reading speed the

most, with a slight advantage to 2 pt. Tinker and Paterson noted that leading logically varied with type size, and that this study was conducted only with 10 pt. type and 19 pica line length. They also stated that 4 pt. leading, while also effective, was not warranted due to the amount of space such a layout took up.

IX. Reductions in Size of Newspaper Print

The ninth study conducted by Tinker and Paterson (1932) did not have as much relevance as the other studies to practice today. They looked at legibility factors in reduction of newspaper print which might take place in libraries due to the deterioration of newsprint and space considerations. Today we use microfiche and computers to render type totally inaccessible, only to restore it to readability through technology. Study nine found that newspaper print could be reduced up to 50% and retain readability. Reduced to 30%, too much legibility was lost. All type was set solid except one section, which proved most legible, set with 1 point leading.

X. Style of Type Face

Due to continuing debate among editors, advertisers and printing experts on relative legibility of type faces, a study of suggested type faces selected by professionals in these fields was undertaken. Seven common type faces, Scotch Roman, Garamont, Antique, Bodoni, Old Style, Caslon Old Style and Cheltenham, were presented to readers along with less common types, Kabel Lite, American Typewriter (less common on the part of printers) and Cloister Black. Each type was compared with Scotch Roman. No difference was found between the first six and Scotch Roman nor between that type and Kabel Lite. Differences were found when a comparison was made with American Typewriter (5.1 % slower) and especially with Cloister Black, which slowed reading 16.5 %. Writers recommended common type forms from this point forward with reminders that subtle differences between type form is insignificant.

XI. Role of Set in Typographical Studies

As an education in how lines of research develop, the Tinker/ Paterson studies were helpful. The eleventh study was another reaction to criticism from other researchers concerning the equivalence of Forms A and B.

Critics suggested that differences between Forms A & B were due to "mental set" on the part of participants in the shift from reading one kind of type on Form A to a different type on Form B. They felt that it was unclear whether typography or "mental set" accounted for lower scores on the second form.

> "In other words, the 'set' developed in reading the standard Form A arrangement is disturbed when subjects are required to shift to a changed typography in Form B. Thus, critics assert that the lower scores in Form B may be due either to less effective typography or to 'set' or to both" (1935).

In this study they reversed the order of type faces presented and compared differences found with results on the previous study. Instead of scores on Forms A & B set in Scotch Roman compared with Form A in Scotch Roman and Form B in Cloister Black, conditions were reversed. The first group read Cloister Black on both Forms A & B. The second group read a non-optimal type, Cloister Black, on Form A and an optimal type, Scotch Roman, on Form B. In a test of 200 college students they found that the Cloister Black group showed no significant difference between speed of reading Forms A & B. The second group performed equivalently *faster* on Form B when it was set in Scotch Roman as Form B equivalently *slowed* performance when set with Cloister Black. Tinker and Paterson concluded that typography, not "mental set," is responsible for the difference in performance on the two tests.

XII. Printing Surface

Study twelve investigated printing surface as a factor in speed of reading. Egg-shell and Enamel papers were compared. While no significant difference was found in speed of reading, Tinker and Paterson caution that results for extended periods of time may be different from the results reported here.

XIII. Methodological Considerations

The last article in the series was a review of the articles generated and of the methodology of those studies. Tinker and Paterson acknowledged certain difficulties with empirical methods in past and present studies. They explained their methods for checking on validity of 1) equivalence, 2) sampling errors, 3) testing procedures, 4) reliability, 5) length of reading periods, and 6) use of control groups. They felt that they had amended procedures in response to criticism and had re-established validity of procedures and results accordingly. They stated, in this final article that they had reviewed their procedures and controls so that others could duplicate their work and to give evidence that their methods suited their goals.

Figure 1 at the end of this chapter summarizes the 13 studies.

Other Studies

Tinker's other work will be demonstrated more clearly later, but an overview is appropriate. Details of later studies as well as the original thirteen will be discussed in Chapter 7. The diversity within Tinker's search is impressive. References for the studies mentioned below can be found in the bibliography and will not be specified here.

While Tinker favored optimals of 10 point type, 19 pica line length and 2 point leading found in the original studies, the range of acceptable variation established by Tinker's (and Paterson's) investigations extended on both sides of these specifics. They found that type size such as 6 point and 14 point slowed readers down as did excessive line length (i.e. 40 picas) and material "set solid" (no white space between lines). They established that a range of 9 to 12 point type allowed the most efficient reading. They addressed practical reading issues such as newspaper type as well as type in book form. Although both 2 and 4 point leading between lines was effective, they viewed those results from a practical standpoint, recommending use of 2 point leading in order to save paper.

Styles of type did not prove particularly significant except in the case of extremes such as Cloister Black (similar to Old English) type. Interestingly, as mentioned, American typewriter was found to slow readers down about five percent, while legibility was enhanced when viewing it from a distance.

Tinker conducted studies of eye movements involving typography which revealed changes in fixation, pause duration, and regression in response to changes in typographical factors. When poor typographical conditions were presented, fixations became more frequent, pause durations longer, and/or regressions more commonplace. These factors combined to slow readers down. Readers of these studies often thought Tinker was studying eye movements, when actually he sought evidence of change in reader function *as a response to* typography. These studies too can be found in the bibliography.

A third area of investigation was Tinker's work on illumination. He found that approximately 25 footcandles were quite sufficient, in contrast to those (like engineer Matthew Luckiesh, see Chapter 6) who proposed higher light levels. He recommended, for example, lighting work areas with higher illumination levels than the surrounding area. He opposed high intensity bulbs which cause eye fatigue.

A simple listing of the variety of factors studied by Tinker, with and without Paterson, gives an idea of their breadth and depth.

Factors Studied By Miles Albert Tinker:

Journal of Applied Psychology series:

1928 Type **form**
1929 **Size** of type
1929 **Length of line**
1931 Simultaneous **variation** of type size and line length
1931 **Black type** versus white type
1931 Variations in **color** of print and background
1932 **Leading**, or interline spacing
1932 **Styles** of type face
1936 Printing **surface**

Other Typographical studies:

1928 **Numerals vs. words**
1928 Relative legibility of letters, digits and **mathematical signs**
1930 Relative legibility of Modern and Old Style **numerals**
1932 **Color** of print and background
1938 Part-whole **proportion** illusion in printing
1942 **Reader preferences** and typography
1943 **Comic books**
1944 **Criteria** for readability
1946 **Yearbook** typography

Newspaper typography:

1943 **Newspaper** body types
1944 **Wartime changes** in newspaper body types
1946 Newspaper **headlines**
1946 Newspaper type
1946 Newsprint and book **print**
1947 Newspaper type
1963 **Simultaneous variation** in size of type, width of line and leading for newspaper type

Children's needs:

1935 Typography for **children**
1953 Size of type in **primary** grades
1959 Print for **children's** textbooks
1963 Legibility of print for **children** in the **upper grades**

Miscellaneous:

1948 **Marginal** conditions
1948 **Blink rate**
1949 **Nine point** type and line width and leading
1953 **Vibration** effects with six point type
1954 **Slanted** text
1955 Typographical **variations**
1956 **Angular** alignment
1956 **Sloped** text
1957 **Curved** text

Eye movements, influence of:

1939 type **form**
1940 **line width**
1941 Modern type face and Old English
1942 **size** of type
1942 line width for **six point** type
1944 optimal and nonoptimal typography
1944 black print on white, red on dark green
1955 **vertical** and horizontal arrangements
1957 typographical **variations**
1957 **color** of print and background

Illumination for reading:

1943 **newspaper** type
1952 **six point type**

(see bibliography for general illumination level recommendations)

Books:

1940 **How to Make Type Readable** (with Donald Paterson)
1963 **Legibility of Print**

A structure for conceptualizing these results of these studies is proposed in the Zone of Optimal Typography, Chapter 7. Illustration of some results of these studies can be found in Appendix C.

Study	Sub. per group	Total sub. tested	Chap/ Cook test	Control group used	Experimental Results -- Zone of Optimal Typography (ZOT)
1. Type Form	80	640	yes	no	Lower case is more leg. than italics or all caps.
2. Size of Type	80	2260	yes	no	10 pt. best of 6, 8, 10, 12, 14 19 pica, set solid
3. Line Length	80	560	yes	no	80 mm (19 pica) best. 75-90 mm recommended
4. Forms A & B Equivalent	235 315/140	690	yes	yes	Forms A & B equivalent for 1st time test takers only
5. Size/L.L.	80	400	yes	yes	8 or 10 pt. w/varied line line length is equivalent
6. Blk. vs Wht.	140	280	yes	yes	Blk on white is optimal
7. Color	85	850	yes	n.a.	Brightness contrast more significant than color.
8. Leading	100 94	194	yes	yes	2-4 point is best. 0 - 1 pt no diff (10 pt. 19 pica)
9. Type Reduc	90	360	yes	no	Up to 50% for 7 pt.
10. Type Face	90	900	yes	no	Standard type faces are equivalent. Am. Typewriter, Cloister Black, non-optimal
11. "Mental Set"	100	200	yes	yes	Type more significant than mental set
12. Print Surface	95/85	190/255	yes	yes	No sig. difference
13. Method. Review	Discussed: equivalence of test forms, sampling errors, testing procedures, reliability, length of reading period, use of control groups.				

FIGURE 1 **Tinker and Paterson's Original Thirteen Studies: A Summary**

CHAPTER 5

Luckiesh

Tinker's interests and activities might be viewed as boringly stable. He taught history of European and American psychology, directed the experimental laboratory, and always taught one laboratory class. He also taught reading, wrote his articles, directed theses, and attended to all the normal tasks inherent in a career in higher education.

Every summer Tinker and his family went to Massachusetts where he spent time on intellectual activities with friends. Then he returned for another year of teaching, writing, and conducting business at the University of Minnesota Department of Psychology.

Reading Tinker's work leaves an impression of satisfaction with the simple pursuit of the intellectual endeavor called research. This may have been as important to him as study of reading or typographical factors per se. The fact that he pursued study of typography so intensely and over such a long period reveals that Tinker felt his results were not only significant, but also important.

Writing about Tinker does not excite one's imagination except in relation to his research vision. He was a quiet, stable man who cared for his family and friends and fulfilled his responsibilities. Controversy often seems more worthy of our attention than the noble efforts of a hard working contributor to the betterment of human endeavor. But his hard work did make a unique contribution from which modern research may profit.

One controversial occurance in Tinker's professional life caused him great distress, demonstrated how he responded to adversity, and showed the character of the man. It was the great conflict of his life. His adversary was Matthew Luckiesh, a writer on visual illusion and perception (1922). For a man like Tinker this conflict revolved around his sense of ethics and morality in research. Unfortunately this conflict occurred with a man who might have been Tinker's closest ally in his search for optimal typography for reading.

Matthew Luckiesh was Director of the Lighting Research Laboratory, Lamp Department, for General Electric in Nela Park, Cleveland, Ohio. He was an early investigator of a similar line of inquiry to Tinker's, sometimes with his co-author Frank Moss. Luckiesh's interests were not finely disciplined along psychologically

scientific lines. He wrote on such subjects as color, illusion, lighting, and typography. While he referenced few authors on typography besides himself and Moss (1939, 1941a, 1941b, 1942), he ignored Tinker's work. As a man who valued interaction with other people, Tinker found this personally, professionally, and ethically most offensive.

Reviewing professional journals and research articles reveals insufficient understanding of the temperaments of these two men. Tinker retained two letters from Luckiesh which provide insights into Luckiesh the man, why Tinker was so interested in trying to replicate his work, and why Tinker became frustrated in the attempt.

The first letter was dated "February Twenty-three, 1939" and was a response to Tinker's "letter of February 21" (which was unavailable). These letters show that Luckiesh provided Tinker with equipment and resources to replicate his work,

> "I won't attempt to answer all the questions because our conclusions and the reasons for them are described in our various publications."
> (Letter, Luckiesh, to Tinker, Tinker family files)

Apparently Luckiesh felt that Tinker either had not read or had not understood appropriate information which was already presented. He gave no specific references.

> "I presume you have received the portable Luckiesh-Moss Visibility Meter by this time. We mailed it on February 21. The scale entitled "Recommended Footcandles" should be "Relative Footcandles". This was an error in the original dies which we have not had an opportunity to correct until now....
>
> The scale represents recommended footcandles only when one accepts the visibility of 8-point Bodoni Book Monotype well printed on opaque white paper and illuminated to 10 footcandles in certain specified surroundings as we have described in our book and elsewhere. If you desire a laboratory model of our Visibility Meter, you can order it from me personally. I will have it built for you." (ibid.)

A generous offer.

> "In regard to our "blink meter", this is not a simple device as the term implies. In all our researches in developing the blink rate into criterion, which

> involves a dozen major researches and many minor ones, we have actually counted blinks in order to avoid any possibility of apparatus attached to the head vitiating the results." (ibid.)

Luckiesh believed that increased blink rate meant that the reader was having increased difficulty processing imagery. Conversely, lower blink rate signified easier processing. A "blink meter" implies more than a person counting blinks. The imprecision and possibly deceptive nature of this term would cause considerable disturbance to a precise and methodical man like Tinker whose forte was apparatuses.

> "However, we have recorded them electrically by two electrodes placed properly near the eye, but not interfering with it. This requires high amplification, but we do it rather successfully with the same apparatus that we have perfected for making electromyograms."
>
> ...We have various reasons for believing that 12-point type is practically the optimum in size, but I do not believe that any methods or techniques are sufficiently comprehensive to establish either 11- or 12- or even 14-point type as the absolute optimum. I am very familiar with the fact that the great majority of newspapers use 7-point type (page 258 THE SCIENCE OF SEEING)." (ibid.)

While Luckiesh took credit for nationally influencing changes in newspaper typographical practice, he specified none.

> "Through work which we have done and interest which we stimulated, we were successful in getting a number of the prominent newpapers in this country to increase the size of their type appreciably several years ago. As a consequence I would estimate that several hundred newspapers made changes for the better due to our researches. We have actually been in touch with perhaps 100 of them. There has been some drift from the average of 7-point to 7-1/2 point."

Luckiesh continued:

> "We have much unpublished work on type and typography which we have completed in the past two years. We have been very agreeably surprised at the

sensitivity of our blink-rate criterion. All this work leads to the inevitable conclusion that visibility must be high in order to have high readability. There is some promise that measurements of visibility will be adequate for measuring readability in many cases provided certain qualifications are kept in mind.

Luckiesh went on to negate Tinker and Paterson's methods:

"As far as speed of reading is concerned, for twenty-five years our laboratory has done a great deal of work on the relation between speed of production (reading, etc.) and various factors in seeing. We have found outstanding cases where the difference in speed of reading, for example, was very slight notwithstanding an enormous difference in difficulty of the seeing tasks."

His following comments gave strength to Tinker and Paterson's methodology, presumably unknowingly, since Tinker and Paterson consistently obtained significant results under (in Luckiesh's view) adverse conditions:

"We have so much fundamental work along this line that we are convinced that at best speed of reading is a relatively insensitive method. We measure speed of reading in connection with other criteria because we want to complete the comparative data. We determine normal speed of reading and maximal speed of reading. In our paper, "Effects of Leading on Readability", we describe three methods of measuring speed of reading and we consider two of them quite normal and certainly not "highly artificial".

As far as leading is concerned, the optimum expressed in points depends on the size of type, the style, and perhaps other factors. However, speed of reading in our work has gone far beyond the old idea that the rate of doing work is a measure of the difficulty of that work. There are too many other factors involved for this to be true." (ibid.)

As Luckiesh explained it:

"I am sure that none of us believes that our knowledge of seeing is complete. In fact one of the greatest opportunities that came to our laboratory was our realization many years ago that the science of vision

and the criteria and techniques in the study of vision were inadequate, which led to our defining seeing as far different from vision and to developing basically new scientific approaches.

As to levels of illumination, I think we have shown from various approaches and many major researches and countless minor measurements and experiences that the whole basis of judging illumination was either largely empirical or founded upon inadequate concepts, criteria and data." (ibid.)

Luckiesh went on:

"I decline to argue very much either in correspondence or in print. I have had twenty-eight years' experience in creating and prosecuting researches and it is my policy to let our published researches tell their own story.

I can say without qualification that a great mass of alleged research on the subjects of vision, seeing, etc. which has appeared in psychological journals is woefully misleading and inadequate due to a lack of appreciation, specification and control of certain factors which greatly influence visibility, and therefore the results of seeing." (ibid.)

Perhaps he was eluding to Tinker's and Paterson's work in his reference to "a great mass of alleged research on the subjects of vision, seeing, etc." He went on:

"However, none of us can justly claim to have complete knowledge or a complete picture in our imagination of anything as complex as seeing. Our statements of yesterday are bound to be re-interpreted and extended by the knowledge of today, and the same applies for today and tomorrow.

I appreciate your interest in our work and I assure you that we are used to being confronted with sound criticism. In fact, we have the policy of being severe critics of our own work.

However, I do not like criticism that is based upon publications of ten or twenty years ago when the time intervening has seen the publication of an enormous amount of work which supersedes the former.

> Scientific attitude should be carried into the examination of knowledge and conclusions already available in publications just as it is necessary in the prosecuting of one's own new work." (ibid.)

A problem of logic appears in Luckiesh's desire not to be held accountable for past work while pointing to his long years of experience as validation of his techniques. While he suggested bringing "scientific attitude" to work "already available in publications", one must imagine that he was referring only to his own work since he has already commented on reasons for ignoring Tinker's work. He apparently didn't believe Tinker was bringing "scientific attitude" to Tinker's analyses of Luckiesh's work.

> "I am inclined to read technical and scientific papers for what they are, assuming that they contribute something positive to knowledge. It is unnecessary and unfair in most cases to asssume that they contribute everything or have completed the entire picture. I prefer to appraise, and praise if possible, the contributions that are made, and not to criticize what has not been done." (ibid.)

Yet he stated previously that he preferred not to discuss others' work in print or correspondence. Luckiesh took credit for major changes, this time opening up whole fields of study:

> "Thanks for your comments on our book, THE SCIENCE OF SEEING. Two-thirds of the references at the end of the book represent the work of others. Considering that our book deals with fields which we have particularly opened and cultivated, I think this proportion speaks for itself. We have a very extensive reference file and our daily lament is that so little work is being done as yet along the lines of our broader concepts and approaches to seeing. Some time when you contemplate being in this vicinity, you might plan to spend a day with us." (ibid.)

Luckiesh's letter showed little humility. In fact, he made rather large claims for the influence of his work which he felt no need to substantiate.

Four years later (1943) Luckiesh wrote again. He thanked Tinker for his letter, then repeated his assertion that Tinker had not read his work closely. He declined to specifically answer questions in Tinker's letter.

"I believe that with a more detailed reading of our book you will find several points in your letter adequately answered. We make no claims beyond our data and statements in the book. Of course, in a volume of this size perhaps we made some slips, and doubtless there are some unclear spots. However, I hope you will look for the good in our work. No one knows better than we do that such work is far from complete. However, I felt it was our duty to coordinate our many years of research on this subject into a book for the convenience of others.

We purposely avoided the responsibility" (?) "of analyzing the work of others in this early stage. Besides, we have had an adequate amount of our own work with new techniques to make a book of practical size."
(Letter, Luckiesh to Tinker, Tinker family files)

Luckiesh dismissed research from Harvard with no indication of why that work was unrelated to his.

"In regard to the work of the Harvard Fatigue Laboratory, I would state that their work in the blink-rate has been extremely meager. As such, it has little bearing upon the rather extensive structure of knowledge that we have built." (ibid.)

Finally, Luckiesh reiterated his view that Tinker did not know his work well, and reminded him of his years of investigation.

"Later, as you have more opportunity to go over our book in detail, I would be very glad to have any constructive criticism that you might wish to offer. I hope that you will give some of our techniques a fair trial. Certainly we have invested many years in a continuous series of researches." (ibid.)

Tinker decided to take Luckiesh up on his offer to give his techniques a "fair trial".

"My own policy is to offer some constructive criticism but to give most of our time to obtaining data. After all, progress is largely due to the development of new concepts, criteria, devices and techniques. We think we have contributed a great deal along these lines."
(ibid.)

Luckiesh reiterated his view that Tinker lacked familiarity with his work and that speed of reading was "insensitive."

> "I hope some day we can sit down and discuss matters for hours. I believe a personal contact would achieve a great deal. In some of your criticisms I note that you ignore a vast amount of work we have done which cannot possibly be controversial. On the other hand, we have not found speed of reading, as determined by appeciable and even long periods of reading, to be sensitive." (ibid.)

Luckiesh felt that Tinker had not proven the validity of speed of reading. He claimed use of the term "readability" as his own, while Tinker considered this term to have originated with his and Paterson's work.

> "Furthermore, I am not familiar with any data supplied by you which prove in any way that speed of reading is a criterion of ease of reading or of what we have termed readability. One must prove that a criterion appraises what it claims to appraise. I would be pleased to have you straighten me out on this point."

He suggested a line of inquiry for establishing speed of reading as a valid measure.

> "Have you performed an adequate series of "axiomatic" researches which prove that speed of reading measures ease of reading? This cannot be accepted without proof. Of course, it might be accepted for extreme conditions, but I am interested in small differences in type-size, type-face, leading and all other controllable factors in seeing as well as in large differences. I try to be fair with you, and I hope you mean to be fair toward our work. I have generally avoided discussing your work publicly because I believe your criterion is insensitive and inadequate. In addition, I prefer to present our work. Others interested can judge as they wish." (ibid.)

Luckiesh infuriated Tinker. "I won't attempt to answer all the questions because our conclusions and the reasons for them are described in our various publications" (February 21, 1939) "I believe that with a more detailed reading of our book you will find several points in your letter adequately answered." and "Later, as you have

more opportunity to go over our book in detail....." (February 23, 1943) Tinker had apparently asked precise questions (Tinker's letters are not available) to which Luckiesh repeatedly responded by admonishing Tinker to do his homework and study his previous publications more closely. Luckiesh claimed national influence while alluding vaguely to results in his publications. Luckiesh referred to his decades of work while disavowing accountability for it. Little of his response to Tinker was precise.

Since Tinker was driven by systematic inquiry, these vague responses which offered no hard evidence could not have been tolerable for this methodical man. Luckiesh signed "With kindest regards," adding a handwritten note that Frank Moss had died. "He had not been in the best of health but his passing was not even in my remotest thoughts". (ibid.)

Tinker's response was dated February 25, 1943. Personal considerations took priority in his response:

> "I am shocked and very sorry to hear of the death of Dr. Moss. I met him in Washington about three years ago and liked him very much. Science has suffered a great loss. I did not know that he had been ill. Thank you for the comments on my letter. Perhaps some of the material appeared highly critical, but it represents my reactions. Nevertheless, I do appreciate greatly a large part of your work and frequently quote it in my writing. Your laboratory has a noteworthy record.
>
> I, too, hope that we may have the opportunity to sit down one of these days and discuss things at length. Probably we are not so far apart on many issues."
> (Letter, Tinker to Luckiesh, Tinker family files)

Tinker indicated he was pursuing Luckiesh's work (presumably in his usual methodical way) and would soon have results.

> "I have planned, or have underway several studies employing your technique. I have just completed gathering data comparing visibility, perceptibility and speed of reading text in various type faces. The data are not yet analyzed. In another study I am working on the reliability of the blink technique with other techniques." (ibid.)

He defended his original use of the term "readability".

> "You will remember that in our typography studies, where speed of reading was the measure employed, we emphasized the differences discovered but did not claim that other techniques would not reveal differences where we found none.
>
> It seems to me that we were the first ones to use the term "readability" in our book "How to Make Type Readable" and in some of my own writing. As a matter of fact, I believe you and I have about the same thing in mind. For some time I have been dissatisfied with the term "legibility." Further work and discussion will help to clarify terminology.
>
> I hope that you will continue work and writing in the field. Let me take this opportunity to thank you for the set of your reprints recently sent me. I always read them with a great deal of interest and profit. War work has cut down my writing by considerable, but I am continuing some. I shall, of course, send you reprints whenever material is published." (ibid.)

While wishing to continue on good terms with Luckiesh, the studies Tinker conducted after these letters were written verified few of Luckiesh's claims. It is not known at which point Tinker was most disturbed by his interactions with Luckiesh, but causes for his frustration were evident in this correspondence.

Review

In 1942 Luckiesh wrote a book entitled Reading as a Visual Task which Tinker reviewed in the Journal of Applied Psychology (at this time edited by Donald Paterson). Tinker began his review stating that the book focused on visibility and readability (also defined as ease of seeing) of print. He said Luckiesh used measurements of rate of blinking, muscular tension, heart rate, fatigue of extrinsic eye movements, pupillary changes, and reading rate to assess ease of seeing. Luckiesh (and Moss) felt that rate of blinking was a most valid measure of readability, a point of view with which Tinker disagreed. (Luckiesh and Moss, on the other hand, did not see rate of reading as a viable measure.)

Tinker agreed with certain points made by Luckiesh and Moss, specifically on the importance of maximal brightness between ink and paper, use of non-glossy paper and ink, clarity of duplicated

materials, ratio of light in the reading area and surroundings, avoidance of glare, and correction of visual defects. He was critical of Luckiesh and Moss's measurement techniques and stated that he felt they misinterpreted associated literature, due to "inadequate appreciation of certain fundamental principles of reading" (Tinker, 1943a, p. 118).

Response

Luckiesh did not take Tinker's review lightly. While his response began mildly, "Some of his statements are so obviously at variance with some important facts that I am impelled to make a few brief comments" (Luckiesh, 1943, p. 360) Luckiesh's defense of his work became quite vehement. He pointed out his "more than three decades" (pg. 360) of research in the area attempting to find a criterion for measuring ease of seeing. Luckiesh felt Tinker ignored his "decade of researches" (pg. 360) on rate of involuntary blinking and could not produce references which demonstrated his claim that "other experimentalists have concluded that the rate of blinking is not a valid index of visual fatigue" (Tinker, 1943a, pg. 116-117).

Luckiesh said Tinker "clings to rate of reading as a measure of readability", (Luckiesh, 1943, pg. 361) which he (Luckiesh) found was an insensitive index. In reference to Tinker and Paterson's 1940 How to Make Type Readable, Luckiesh said it was "devoid of analyses of his data as to reliability. Probable errors are notably absent." He said that "no work on the heart-rate during reading has been done which is comparable with ours" and that "Dr. Tinker appears to be little acquainted with" geometric or arithmetic means. (ibid.)

Luckiesh's response became progressively more aggressive. He called Tinker's views "obvious prejudices" and referred to his "apparent lack of understanding of subjects with which I have spent a lifetime and with which he has not." (ibid.) He said "(Tinker) exhibits a lack of familiarity with some of the fundamental facts" (ibid.) and again referred to his own several decades of work.

He accused Tinker of "gross ignorance" (ibid., pg. 362) of fundamental factors, and stated:

> "At least our life-long association with these fundamental aspects of seeing conditions is a guarantee of high control and adequate recognition of these factors which are commonly absent in Dr. Tinker's criticisms as well as his work." (ibid.)

Again he brought up his long experience while saying he has "no dogmatic adherence to the past." Irony waited at the end of

Luckiesh's response. He said "Dr. Tinker's attitude is revealed by his criticism that our book was printed in 11-point type, 23-pica line-length, 2-point leading, on moderately glossy paper."

While stating that "Dr. Tinker seems to think that the typography should have represented what we would conclude is ideal" (ibid.), the fact is, Luckiesh described typographic parameters which, except for the use of "moderately glossy paper" (which Luckiesh denied), were standards which Tinker found to be within ideal range in his own research, of which Luckiesh was apparently ignorant.

Luckiesh concluded with indications that his response could have been more extensively aggressive (!) were it not for space limitations. (ibid.)

Tinker's response was strong, but firm (Tinker, M. A., 1943b). He said that Luckiesh's belief that it was acceptable to quote strictly from one's own laboratory results was "inexcusable" (ibid., pg. 469) when there was other evidence which was not in agreement, and he gave references, two of his own, which contradicted Luckiesh. He pointed out that "other factors than mere ability to perceive printed symbols accurately are involved in readability" (ibid.). He gave references for his views on limitations of rate of reading as a criterion of readability and Appendices which offered proof. Sensitivity factors and controls were shown along with information about reliability and probable errors. Paterson co-authored How to Make Type Readable (1940), where this proof was found.

Tinker referenced data which contradicted Luckiesh's points about the validity of blink rate as a measure of readability, and disagreed with the validity of quoting solely oneself simply because "he has done nearly forty studies using the technique" (p. 470). He discounted Luckiesh's point about heart rate and listed several points he made in his original review to which Luckiesh did not respond. He said that lack of agreement did not necessarily indicate prejudice and that:

> "Luckiesh or any one else is not immune from criticism merely because he has spent a lifetime in some field of research.....research should be evaluated in terms of its merits, not in terms of how long the experimenter has been working in the field." (ibid., p. 471)

In fact, Tinker said that Luckiesh did not make use of all facts available for his work in typography, but "employed inadequate materials derived from his own research." (ibid.) Tinker concluded with the observation that use of typography in Reading as a Visual Task was "better than if their specifications had been employed" (ibid.), and that most of his and Paterson's book did indeed fit their specifications with a few necessary changes. He finished with:

> "To write authoritatively in the field of reading it is necessary for the author to have an adequate knowledge of the fundamental principles of reading. The authors of Reading as a Visual Task reveal a lack of this knowledge, especially in the field of perception and eye movements. Nevertheless, as stated in my review, there is much of real value in their book." (ibid.)

One result of this clash with Luckiesh can be seen in a series of articles Tinker completed from 1945 to 1950, three appearing in the Journal of Experimental Psychology and two in the Journal of Educational Psychology. This series of articles took Luckiesh's research to task.

The first article (1945) compared blink rates during a series of reading periods. Correlation of blink frequency was quite high as long as comparisons were adjacent in sequence. However, correlations varied when comparisons were made from varying parts of the series (like time periods that are separated by 20 minutes).

Rate of blinking among subjects over time in the series were also inconsistent, some increasing in frequency as time went on while others decreased. Tinker concluded that blink rate was reliable for adjacent measurements, unreliable for intervals separated by 20 min. or more (such as the first and sixth intervals), and that it was valid for reliable measurement of group performance.

He proposed that the next study be on blinking as a criterion of readability. It was no surprise that the second blink rate study focused on "frequency of blinking as a criterion of readability." Tinker said that Luckiesh and Moss saw blinking as a highly sensitive indicator of readability. He compared blinking on tasks involving all capitals and lower case type, factors he and other experimenters had tested in previous studies. Differences in the typographic comparisons were similar to previous studies, but similar results were not found with respect to blinking frequency.

In conclusion, Tinker stated:

> "...much of the evidence put forward by Luckiesh and Luckiesh and Moss in the field of illumination and typographical arrangements is worthless and ... the recommendations, therefore, (are) without sound foundation." (Tinker, 1946, p. 459)

In other words, Luckiesh's integrity as a researcher was being questioned.

The next study (1948) responded to accusations by Luckiesh that the test procedures used by Tinker (and Paterson) were not similar enough to his own to produce the same results. The aim of this study was to duplicate Luckiesh's procedures and experimental conditions. Specifications were listed along with a couple of additions by Tinker, specifically, an adequate number of subjects and statistical evaluation of the significance of the differences found.

A past study by Paterson and Tinker (1946) had shown that newsprint was read significantly slower than book print with optimal typographic arrangements. Book print was set in twelve-point type, two point leading, and a twenty-three point pica line width. Newsprint was set in seven-point type with one-point leading and eleven and one-half pica line width. Correlation between blink rate performance for these two conditions was quite high (.95).

Other studies, however, had shown the book print arrangement to be more readable for rapid and easy reading. Since the experimental set-up was considered valid, Tinker saw the alternative explanation for the lack of difference in the blink rate index as being "the blink rate is not a valid measure of the readability of print" (Tinker, 1948, p. 38), and he suggested further testing of the validity of this technique.

The fourth article (1949) again sought to find validity for the blink rate method, this time by a comparson of blinking under low and high illumination. While reading under 2 footcandle light conditions is a more severe visual task than that for 100 footcandle conditions, one might assume blinking would be higher under the former condition than the latter. However, Tinker found the opposite. Further, in relation to the prior study, he found that there was little difference between performance when comparing the first to the last five minute sessions within the total of 55 minutes. Tinker concluded:

> "It would seem that the differences cannot be assigned to differences in experimental method and probably not to differences in size of groups studied.

Apparently the source of the lack of agreement must be sought elsewhere." (Tinker, 1949, p. 560)

Tinker's last article involving blink rate (1950) reviewed data on blink rate with the conclusion that this method held no advantage for the researcher. Gordon Tinker said that his father found no way to replicate Luckiesh's work and therefore he could only conclude that Luckiesh lied to support what he thought, or wanted, to be true. Tinker's only conclusion was misrepresentation. This enraged him. Gordon Tinker remembered his father uncharacteristically "walking around the house calling Luckiesh names, like 'that Luckiesh s__ of a b____'..., He hated Luckiesh," said Gordon, for what Tinker saw as his unethical approach to scientific inquiry. (Personal communication, Gordon Tinker, May 18, 1988, Seattle, WA)

The effect on Tinker's son Gordon became a life-long lesson. Gordon found it disturbing for his mild-mannered father to be so professionally distressed, and vowed in his own adult work not to let professional problems reflect in his own home life and distress his children. Tinker unintentionally taught his son to leave professional unpleasantness at the office.

At Tinker's retirement dinner, Paterson delivered a tribute. He reviewed Tinker's academic accomplishments in detail and alluded to his skirmishes with Luckiesh:

> "The invitation to attend the Nela Park conferences mentioned as the last item in the preceding paragraph came, however, only after M. Luckiesh retired at the Nela Park Laboratories. This fact itself is hightly significant since it represents a continuing controversy (running battle would be a better term) between those who believe in excessively high levels of illumination and Tinker's findings which suggest far lower levels as being efficient and hygienic." (Paterson tribute, 1959, Tinker files, University of Minnesota Department of Psychology)

Paterson mentioned benefits from this traumatic interaction.

> "As a matter of fact, it was this controversy which persuaded the Northern States Power Company to install, as a free gift, the lighting laboratory facilities in Room 117A which has enabled Tinker to continue to show, in experiment after experiment that so-called illuminating standards advocated by many illuminating engineers are excessive, unhygienic and uneconomical.

> The behind-the-scenes aspects of this controversy were quite exciting. At one time there was an attempt to prevent the publication of one of Tinker's earliest papers on this subject. It was a fool-hardy business, because it undoubtedly drove Tinker to conduct a large number of carefully controlled experiments on illumination which he otherwise might never have pursued. This controversy bears testimony to the fact that America's system of free enterprise is truly linked with free inquiry." (ibid.)

The memories of both Paterson (in Tinker's retirement testimonial) and Tinker's son Gordon indicate that this was the most disturbing professional relationship of Tinker's career.

It was unfortunate that Luckiesh, a person with the most similar research interests to Tinker's outside of his co-author Donald Paterson, could not work with Tinker. An investigation into Luckiesh's research and integrity are beyond the scope of this investigation, but the Tinker's personal integrity revealed by his training and professional conduct indicates that Tinker sincerely believed that Luckiesh was a betrayer of science.

CHAPTER 6

Tinker's Impact on Practice

Tinker pursued one of the most extensive inquiries into the effects of typographical factors ever conducted. His work is largely unknown for several reasons. First, a multi-disciplinary area of study did not reach all potential participants during its development. In his own time, the audience of practitioners comprised a small, specialized group. His results were presented in psychological journals and were not generally available to those in the printing industry. Most educators only had typewriters for production of print media unless they engaged a specialist.

Second, when practitioners were presented with Tinker and co-author Paterson's work in How to Make Type Readable (1940), they saw many "proofs" which they felt they already knew. They were insulted that psychologists who had little experence in their specialty presumed to tell them what procedures they should follow.

Third, printers did not understand that Tinker and Paterson's work was focused exclusively on efficiency of processing by *readers*. This work did not presume to dictate design rules. The goal was to establish which factors would allow most efficient processing by the least distraction from typography during the reading process. This concept was not unfamiliar to printers, but their unique ability to accomplish this objective was heretofore reached through a highly developed judgmental skill on the part of artists, not through some dry formula developed by non-practitioners.

First, typographers didn't understand psychological research. Second, they knew (and rightly) that designing print materials involves more than simple concern with how fast someone can read. Only someone of ignorance and poor taste could think that a simplistic formula could be devised which would produce optimal typography.

Response to Tinker and Paterson's research results seemed related to their audience's ability to take action. Armed with knowledge gained through research, psychologists, and reading specialists could better understand how students processed various typographical conditions, but they were only able to act as a secondary audience. They were not in a position to take action guided by these results. Those choices were in the hands of printers,

typographers, and publishers. Only the latter group was in a position to take direct action in their daily work in response to these research results.

Graphic Arts Literature of Tinker's Time

Printing is an art, an art not likely to be well understood by a couple of psychologists evolving a theory of "print by numbers." Printers were insulted and incensed. Whittemore, 1948 ridiculed attempts by psychologists to study a specialty that was hundreds of years older than their own. Tinker and Paterson's (1940) How to Make Type Readable looked nothing like the literature common to the print and publishing industry on the subject of type. It demonstrated few of the design possiblities to which printers and typographers were accustomed. It was visually passive. In order to understand the literature of this audience for Tinker's and Paterson's work, a review of typographical literature is in order.

Some typographical manuals are solely presentations of type, with little advice as to selection and will not be reviewed here. They were assembled for use by a trade in which apprentices learned from masters. In that environment, manuals served as visual education tools. Much common usage was passed by experience, not organized in step-by-step manuals.

In Tinker's time type was usually set in one of two ways: the first (and oldest) through hot metal composition (which often left burn scars on practitioners) or by hand, with compositors picking out and arranging type in forms. The second (new in the fifties) utilized cold type, reproducing letters photomechanically on paper or film. The men (usually) who did this work became highly skilled at both physical and judgmental selection of type. This was not a world populated by scientists, but by practitioners, practitioners who felt they knew more about type than those who had not spent a lifetime setting type. This skepticism continues today, as seen in this review.

Printers and typographers perform a service, and as such are not always able to select type according to their own preference. They are frequently at the whim of the customer who wants to gain attention for a product and who is not concerned with aesthetics as much as with getting attention. Joseph Blumenthal authored an autobiography (1982) of his own "printer's journey through half a century" covering almost the precise years as Tinker's work, 1925 through 1975. He said:

> "Fine printing rarely satisfies business people who want big splashy effects. The industrial

> firms spend money lavishly and expect lavish results. The basic tenets of fine paper with forthright typography do not satisfy where sales are the sole imperative. Nor does business printing satisfy the fine printer. He wants to expend his energies on matters worth printing. Hence the logical tie to cultural institutions who were our mainstay for survival throughout forty-five years."

Blumenthal was not speaking as a scientist, but as an artist. Pride in printing is the same as the pride in anyone who takes their work beyond simple fulfillment of technical requirements. This same echo of artistry came through in other writings by devotees of aesthetics in print which are presented here. They did not believe in "formula" printing, and saw results of controlled research as leading to this approach.

Beginning with the early days of this century, the literature presented here gives an introduction to this point of view up to the present day. One traditional resource for advice on type choice has been publications for designers, especially those involved in advertising. These people needed to make informed decisions in order to solve design problems, and so books appeared with advice on type selection. French (1909) advocated designers taking control of typographical decisions:

> "It is not enough to employ a good printer. The best printer may be a poor advertiser ... it is important that the advertiser know enough about printing to secure for his work the utmost power printing can give it." (p. 199)

French's statement on printing, while a different perspective from Blumenthal's, agreed with him as to the abandonment of fine printing for "splashy" art. It related directly to Tinker and Paterson's work:

> "The motive of printing is not primarily an art motive. It is a utilitarian motive. In printing therefore art is to be invoked for guidance only so far as it will lend itself to the expression of the motive. It is never, in printing "art for art's sake;" it is ever art for printing's sake. We do not print to illustrate art or produce objects of art. We print to spread intelligence, to make knowledge available to all who will read, to sell goods.

> ... In printing it is the story that is told; it is the literary motive that must be considered, first and most anxiously. Nothing may interfere--not even art." (ibid., p. 205)

The problem French describes was similar to intrusions seen by Blumenthat in non-fine printing. French was concerned with the reader, not just the buyer.

> "The shaft of the 'story' must go, swift and true, straight into the comprehension of the reader. This is the constant anxiety of the printer. The literary motive must not be encumbered. It must be absolutely freed from the mechanics of the printed page. This is the printer's problem. He must not seek to attract to his mechanics. It is the essence of his art that he liberate ideas and send them forth with no ruffled pinions, no evident signs of the pent-house page from which they wing their way." (ibid., p. 205-206)

Tinker looked for the "ruffled pinions" and sought to identify them. French's writings showed that the ideas of disencumbering the reader from difficulties imposed by typography was not a new idea. Blumenthal echoed similar sentiments three-quarters of a century later. Such views are classic in typographical literature. French also discussed factors which Tinker's work later reinforced as accurate assessments:

> "In the case of job printing and displayed advertisements all of the displayed lines should be set in capitals or all in lower-case, prefereably in lower-case unless there is some good reason for the use of capitals. ...The eye prefers the natural curved and flowing lines of the lower-case letters, and prefers them for the whole piece. If capitals are used there is another form motive, and there is a conflict between the displayed lines and the lines, or the mass, of the body matter." (ibid., p. 212-213)

And, central to Tinker's interests:

> "...the less (the sensitive eye) is subjected to irritation the more inclined it is to linger on the advertisement and persuade the mind to fix itself upon the statements thus agreeably presented to the vision." (ibid., p. 213)

When Tinker and Paterson found that lower case was read faster than all capitals, printers and advertisers found they had not learned anything they didn't already feel they knew. Consequently, this "new information" made little impact. French spoke to Tinker's interests, but he also spoke to Paterson: "...we are never to forget that advertising is a business..." (p. 216), an issue close to vocationally oriented Paterson's heart.

This conflict between art and earning a living was another classic theme in advertising and print literature. Neither Tinker nor Paterson were typographers. Nor were they designers. They sought the truth of human processing response to conditions of typographical display. Use of the scientific information revealed by their work was someone else's domain, and they did not pretend otherwise. They tried to reach that someone else (printers and typographers) through their first book, How to Make Type Readable, in 1940. This book brought together their original series of thirteen studies for the Journal of Applied Psychology, as well as other scientific studies and suggestions presented in great detail.

For the scientific typographer, this could be a master reference, especially since it provided detailed information on how to conduct this research. However, it did not make the impact for which it was designed. Up to this time (1940), Tinker and Paterson's studies had not impacted the literature significantly with the possible exception of their own area, psychology. Unfortunately the impact in that area was misunderstood (Whittemore, 1948) or resulted in conflict (Luckiesh, 1939).

Tinker and Paterson were not mentioned in Carl Greer's (1936), 474-page Handbook of Advertising and Printing: Advertising and its Mechanical Production, although this book did refer to typographic legibility and gave some of the same examples found in Tinker and Paterson's book. For instance, Greer stated, as did Tinker and Paterson, that upper halves of lines of words are easier to read than lower halves. Perhaps Tinker and Paterson had read Greer's book, though there is no evidence of this in their references. Greer suggested that "in 10-point type, four and one-half inches is as great a width as can be read with ease." Four and one-half inches is 27 picas. Tinker and Paterson would have agreed with Greer, not as an optimal, but within the range of acceptability.

Greer quoted E. G. Gress, "who is recognized everywhere as one of the world's best typographers" (pg.283), in a list of 14 guides to typographic excellence. These points include: using leading (white

space) rather than setting type "solid"; 10 point as an optimal type size for circulars or books; use of standard (as opposed to extended or condensed) type faces, preferably Roman; and lower-case as first choice for easy reading. Tinker and Paterson supported all of these, and backed their support with empirical data. Greer apparently did not feel his audience needed verification through that avenue. Neither did Willard Brinton.

Willard Brinton's (1939) Graphic Presentation was a complete manual for those in printing and advertising. Almost every page in this 512-page volume included graphics to support points made. Specific references abounded, most commonly from government, business, printing, and current literature sources. Information was presented fully illustrated. Brinton even recorded how the book itself was created and planned. While an excellent reference for graphic presentation, Tinker and Paterson's studies were not mentioned, nor was it mentioned by Tinker and Paterson.

By 1947, How to Make Type Readable had been on the market seven years. In that year, Hartley E. Jackson, in Newspaper Typography (Stanford University Press) referenced five books since 1940 in his list of eighteen. Tinker and Paterson's was not among them. Since Jackson was an associate professor at San Jose State College (industrial arts education), he would have seemed more likely than most to quote from scientific studies relating to his field. Apparently Tinker and Paterson's work was not influencing their own time.

One set of articles exists which may indicate why printers and designers did not take this work more seriously. They appeared in the only trade journal in which Tinker and Paterson published. Tinker and Paterson responded to an article by Irving C. Whittemore (1948). The article was entitled "What Do You Mean -- Legibility?." Whittemore wrote satirically about the idea of "proving" that such a concept as legibility existed within a medium that was hundreds of years older than the science which sought to study it.

Whittemore not only questioned the very definition of the word "legibility", he also questioned the certainty of "results" about a topic filled with variables. He referred to a multitude of situations involving print, pointing out that each was different and defied the concept of "optimal" due to intrinsic variety. Whittemore ended:

> "Tinker and Paterson's How to Make Type Legible (sic), the work of two psychologists and in format based on their findings, is about the ugliest, least

> attractive, and uninviting book ever printed. The Harpers designers must have died a thousand deaths putting it through the press. Only someone who had to know what was in it would read it. But it can be read fast, which is what Tinker and Paterson were after. Readable? Or legible?
>
> The Gutenberg Bible: beautiful and inviting, but unreadable. Tinker and Paterson: easy to read, but who wants to!"

It is perhaps significant that this article and the researchers' response to it, was maintained by Paterson in his files until his death (University of Minnesota Archives, Walter Library).

Tinker and Paterson's immediate action was to send the article to other members of their department. They then wrote a response to Whittemore which patiently explained their position. They agreed that the problems of studying readability (their preferred term) were extremely complex due to the very factors Whittemore observed. They also remarked:

> "The practical printer or even the type designer, unless he is fully aware of the psychological factors involved in visual perception is stymied at the outset in knowing or understanding the variety of scientific problems of legibility or readability. Unfortunately, insight concerning one's own ignorance of the complexity of the problem is rarely encountered in the practical printer or the type designer.
>
> For this reason, practical printers or type designers are likely to disregard findings from the research laboratory or at best to accept only those findings which happen to coincide with their own beliefs derived from experience or from erroneously designed laboratory studies." (Manuscript, Paterson file, University of Minnesota Department of Psychology)

Tinker and Paterson then reviewed research approaches, defending those which they believed to be consistant. In summary they designated their interest as being in "the development of optimal typography for the average reader under the ordinary conditions of everyday life" (ibid.), a narrow and specific aim which was not understood by those in the printing industry, as evidenced by Whittemore. No evidence has been found that they published in trade journals again.

Graphic Arts Literature Today

A review of more contemporary literature on typography, advertising, and design revealed that "Tinker's work" (Paterson is seldom mentioned) has survived only minimally. He was most often quoted in relation to his 1963 Legibility of Print or to his eye movement studies (Monty & Senders, 1974) which were often conducted to investigate response to typographical conditions, rather than as eye movement studies per se.

Scanning selected current references reveals how Tinker is (or is not) referenced today. Paterson was seldom found referenced with Tinker in present day literature.

Hurlburt (1976) has authored a number of books on design which were well designed themselves. He discussed type legibility, but apparently had strong doubts about its veracity.

"Many studies have been made of the comparative legibility of typefaces, and each has come up with fractional advantages for one type over another. Many magazines have thrived with words set in less than ideal type, and others have expired with type of scientifically proven legibility.

The answer seems to lie in good words and in the art director's sound, but not necessarily scientific judgment. Perhaps overall readability is a more important yardstick. If the look of the page and its content is sufficiently interesting to the reader, he will read it." (p. 95)

So much for type legibility, in Hurlburt's opinion. His book was set in sans serif type, which advisors such as French in 1909 and since (Brinton, 1939; Greer, 1947) felt was less easy to read. His type choice for this book was sans serif with a had a large body and short ascenders and descenders (Helvetica) which encumber readers, according to Tinker, because they present less word shape, in other words, fewer cues, to assist readers.

Hurlburt did not concern himself with legibility research, disregarding what "scientists" say. This accounts for one reason that Tinker and Paterson's work has made little impact on the design literature. In the case of Hurlburt's book, the author was likely correct when he said that interested parties would read it regardless of type, due to its specialized nature. If designers, as Hurlburt asserted, prefer type such as Helvetica due to its inherent design qualities, Hurlburt "spoke their language" by using a type preferred by his audience (designers). This would logically increase his own credibility among his peers. The choice does not, however, invalidate legibility research.

What is apparent is misunderstanding of purpose. Hurlburt is more concerned with design than reading, as reflected in his writing. In his work this may be appropriate. Reading as a cognitive activity may simply make other demands.

Sandage, Fryburger & Rotzoll (1979), not designers, but advertisers, wrote vaguely on selection of type:

> "Type is meant to communicate, and the more legible it is, the clearer and faster will be the communication. Scientific research has made contributions to understanding of the bases of legibility, but the findings are not complete or conclusive. Legibility and readability are relative terms."

And,

> "What is legible to one person in one situation may not be so to others." (p. 342)

Considering the volume of work that was done, Sandage, Fryburger and Rotzoll might have been a little more specific as to what was found. They recommended selecting type based on "feeling or atmosphere" (p. 343), an intuitive approach shared by designers, but not too precise for those without expertise in the area, which included those most likely to read this book. The book was set in 10 point type with 2 point leading, dimensions which match Tinker's specifications.

Although the mission of this book, according to its title, included theory, suggestions for methods of verifying opinion on typography were absent. This fact is not unusual within this discipline. Scientific data are not the driving force. The predictability sought by the scientific method is an antithesis to artistic creativity, though basic foundations have been developed through analysis of existing design principles.

Lee's (1979) Bookmaking is one of the most complete references on making books, yet no suggestions are made as to verification of typographic effectiveness. Lee gives an indication of why Tinker and Paterson's work was received with less than open arms. "The design and use of type is deeply involved with tradition" (p. 72). Lee observed a fact directly related to Tinker and Paterson's research: "...the findings of psychologists ... invariably discover that people read most easily the type to which they are accustomed" (p. 72)

The problem for the non-printer/non-typographer becomes: What set of factors, described specifically, is the reader used to seeing

and therefore most easily processed? This is part of what Tinker and Paterson found.

Perhaps this way of thinking is old news to typographers, but it is important information for the new audience, those presently making typographical choices to produce materials by desktop publishing and designing computer screens. It would have been useful information in Tinker and Paterson's time (and today) for those involved in textbook selection.

Lee supported Tinker and Paterson's work in his statement, "Typographical trouble can be avoided by following good models, ... but creation of excellent work depends on a highly developed perception." (p. 74).

This statement links Tinker and Paterson's work by implication with typographical practice and stands as a support for multidisciplinary understanding. Lee wrote an excellent and extensive discussion of readability: "Readability and legibility are sometimes considered synonyms; actually, they are not." (p. 89) At times Lee was vague, such as:

"It is said that italic is harder to read than roman..." (p. 78).

If he was familiar with Tinker and Paterson's work, he might have said "studies have shown...". Lee pointed out that a study nullifying the factor of experience is impossible. This statement retains its validity whether addressed to scientific studies or not. Lee listed "no less than nine" factors which affected readability: typeface, size of type, length of line, leading, page pattern, contrast of type and paper, texture of paper, typographic relationships, and suitability to content. Tinker and Paterson studied no less than seven of these.

Lee discussed factors of legibility which were studied by Tinker and Paterson, among them type size appropriate for children, problems of excessive line length, and blink rate (part of Tinker's disagreement with Luckiesh).

McLean (1980) devoted an entire chapter to legibility defining it as "easily read" (p. 42), and mentioning Tinker by name (p. 47), but not Paterson. McLean echoed the sentiments of others in the field:

> "A great deal of research has been carried out during this century into the legibility of print, and also into psychological and physiological processes of reading and comprehension. I believe that no research so far published has been seriously helpful to designers concerned with the design of a straightforward reading

matter for literate adults except insofar as it has, in general, confirmed their practice.

> Research in legibility, even when carried out under the most 'scientific' conditions, has not yet come up with anything fundamental that typographic designers did not already know -- or believe -- with their inherited experience for five hundred years of printing history and their specialized observation of the civilization in which they live. For example, one authority, Tinker, had concluded that 'black print on a white background is over ten per cent more efficient than white on black'. I am glad to hear it, but after even ten years as a typographer it would never have occurred to me to think otherwise." (p. 47)

McLean listed three rules of legibility. The first was, "Sans-serif type is intrinsically less legible than seriffed." (p. 44). He said the reason for this is that "some of the letters are more like each other than letters that have serifs". He differentiated between those who use either type well or poorly, which may nullify this rule. He also referred to design considerations which may have the same effect, and alluded to purpose (sustained reading) in contrast with aesthetic aims.

McLean's second rule was that roman upper-and lower-case is easier to read than any of its variants (italic, expanded, etc.). His last rule pertained to use of white space. He pointed out that often recognition is more important than legibility, and offered logos as examples. McLean asserted that research can indeed be helpful, especially in "special situations" such as for the handicapped, bibliographies, telephone directories, etc., in other words, situations with which typographers may not be familiar. References listed under "legibility" did not include Tinker's work, though he was apparently listed in a book from which McLean quoted Tinker.

Carter, Day and Meggs (1985) presented an excellent blend of design and intellect, offering the reader verbal information which was reinforced by non-verbal information. Legibility was defined as:

> "those qualities and attributes inherent in typography that make ... it possible for a reader to comprehend written forms with the least amount of difficulty." (p. 81)

Tinker and Paterson would certainly have agreed with that definition. In regard to serif versus sans serif type, Carter, Day, and

Meggs said that this was a controversial issue and then stated definitely:

> "the relative legibility between serif and sans serif typefaces is negligible. Reader familiarity and the control of other legibility factors are far more significant..." (p. 84)

Hurlburt made it clear that designers preferred sans serif type. Since designers produced this book, one would assume, if Hurlburt were correct, that Carter et al. were not unbiased in their assessment. Carter, et al. offer full columns of text to compare for visual assessment. I agree with printers, that serif type is easier to read. Who is right? An empirical study might hold more definitive answers.

Tinker included one sans-serif type (Kabel lite) in an early study (1932) but found the difference insignificant. The rank ordering of lower case letters "by researchers" disagreed with Tinker's research. But the reader is not told who produced this ordering.

Carter, Day, and Meggs pointed out many factors to be considered when selecting type which coincide with Tinker's work, but designated no sources for this information. In this book, interestingly, Carter et al. suggested one set of specifications which are directly attributable to Tinker and Paterson: "An optimal line length for the average 10-point type is 19 picas." (p. 87) Tinker prescribed that precise combination. The designation of 19 picas was an odd number to specify unless gleaned from that work. Farther down the same page (87), other Tinker and Paterson data appeared:

> "Research has shown that for the optimum sizes of text type (9-, 10-, 11-, 12-), one to four points of interline spacing can be effectively added between lines to increase legibility." (ibid.)

Then the skeptical designer crept back in:

> "Remember, this is not to say that type set outside these optimum specifications will be illegible, for critical judgment can ensure legibile typography without inhibiting fresh approaches." (ibid.)

This interplay between ideas from research and design allowed verbal and non-verbal information to reinforce each other. Carter et al. discussed a decrease in legibility found in flush-left-and-

right justification. They shifted their own layout to that form and then back to flush-left, ragged right to demonstrate ease of reading.

The intellectual intrigue and stimulation offered could only profit from the inclusion of guidance as to how objective results might be obtained for those who cared to conduct their own research on the variables discussed in this manual. While the primary audience for this book was designers and it was produced by designers, it reinforced quite clearly the reason for this dissertation: Tinker and Paterson's work is still little recognized within the design/typography/printing world and present guides have become sophisticated enough to take the next step of acknowledging empirical support for certain knowledge possessed by designers and typographers.

Authors reference Tinker's work (mostly from the 1963 Legibility of Print) in books designed for use in classroom training of graphic arts professionals. However, these quotations reveal little of the range of results offered in Tinker's research. Crow's (1986) Communication Graphics quoted Tinker and Paterson as showing that 10-point, 19 pica line length were optimals. Conover (1980), in Graphic Communications Today, noted that Tinker showed roman type was preferred, while all-capitals were non-optimal. The amount of research supporting typographical choices discussed in these two books was a considerable change from the days of rules based solely on practice. While Tinker and Paterson were not mentioned as comprehensively as they might be, these more recent books do present a comparatively large volume of research-based evidence, in contrast with older traditional manuals.

If Tinker and Paterson could have designed an audience for their work, that audience would surely be the same as the educational technologists and others presently attending to Hartley's (1987) Designing Instructional Text. However, even Hartley only referenced Tinker's 1963 manual as a summary although most of Tinker's work was directly relevant to Hartley's interests and audience for this book. Many of his remarks could have been substantiated empirically through Tinker's work.

Currency of Tinker and Paterson's Work

There is a search today to verify the effects of processing visual information which might benefit from Tinker's work, with and without Paterson, but which underestimate the potential contribution available. His basic research is seldom quoted anywhere except in summary form (1963). His methodology was sound and while today's

methods may allow more sophistication in experimental design and analysis, the basic work must be reevaluated to avoid attempts to re-do work which is already completed and available but has been forgotten. The diversity of Tinker's work is extensive, as seen in Chapter 4 & 7, especially within the areas of typography, eye movements, illumination, and, both separately and integrated with these factors, reading.

The point of this dissertation is mutifaceted. It applies across disciplines and specialized boundaries. Tinker and Paterson, two well-trained and knowledgable psychologists, tried, in good faith, to test reader response to various typographical factors and came up with results which are as valid today as they were in the thirties. The audience which might have used this information did not embrace it. Fellow psychologists (since they were not typesetters) were not able to use the information directly except to monitor the practice of printers, typographers, and publishers and make suggestions when possible.

For those in graphic arts Tinker and Paterson's findings indicated many appropriate choices which they were already making, especially in fine printing. Joseph Blumenthal's book is a demonstration of a high art which also utilized parameters which happened to have been verified as optimal through empirical research. Blumenthal did not construct his book following Tinker's guidelines, yet those same guidelines provide empirical support for decisions and practice of an industry which is highly skilled and fully competent and which is challenged, today, to defend typographical decisions with empirical data.

Tinker and Paterson are still there (via their research) to support what these professionals know to be true, not as design, but as basic to human processing of print. One wonders if Tinker and Paterson were not studying, as Lee noted, what their subjects were used to as much as what actually might be optimal.

Print had already, as Whittemore (1948) pointed out, been in existence long before researchers entered the arena. Printers were proud of their knowledge and skill. They were not trained in scientific research and often saw science reveal facts that they already knew rather than new information. And researchers insulted them by implying they didn't know this "scientifically" established data, which, generally, they did. Tinker addressed poor typographical choices he witnessed, issuing advice based on his own work. He wasn't as concerned with what typographers were doing right as he was what they were doing wrong. Lack of this differentiation was also offensive.

Art, including design, is primarily concerned with creativity. Prediction is an antithesis to creative people. Their pleasure and life blood comes from the search for the ethereal "what works," not from visual presentation which is so common that it does not disturb the viewer. Design that does not stimulate the imagination is worth little to those who thrive by intriguing and activating the minds of viewers. Therefore, to designers, Tinker and Paterson's work, which searches for factors which do not disturb the reader, might appear worthless. Designers do not design for visual passivity, but for visual activation.

In this sense Tinker and Paterson did not properly address those most likely to directly utilize their results, those in the graphic arts industry. While psychologists found differences in subject response intriguing, designers found "optimals" horrifying in their visual tedium, especially when they saw rigidity in the recommendations. The last thing they wanted was "formula typography."

Lacking was an explanation, to designers, of why study of visually passive factors was important. This was not important to the world of design overall, as to a particular segment whose task was to present information visually for purposes of utility, not visual intrigue. Tinker and Paterson's interest was in print factors which promote efficient reading, not in design variables. Printing for efficient reading is not an exhilarating activity for most printers. It is boring. It is massively hum-drum. And one of the greatest fears and abhorrences for designers and fine art printers is the boring and the hum-drum.

Practitioners needed to understand that Tinker and Paterson never wished to promote a rigid set of principles for all printing situations. They only sought that avenue by which readers would be able to process information most efficiently. They never studied print as an aesthetic issue. Within their own small focus, their information was and is extremely valuable. Designers can use it to aid design principles. If they know certain choices will NOT disturb the viewer, making choices to the other extreme allows the designer to control certainly of visual disturbance in those circumstances where such a goal is desired to elicit the viewers involvement.

One problem with this approach, and an insoluble one, is that printing, like most other aspects of commercial life, is affected by fad and fashion. These were not issues of primary interest to Tinker and Paterson. If design instructors could show with empirical support that certain decisions create passivity while others activate, their

lectures would only gain strength. When is the goal to slow the reader down? White type on a black background might be desirable to attract attention, especially since a slowing of reading speed may cause readers to spend more time processing information about the product being sold. When should the reader be able to ignore visuals in order to optimize transmission and reception of information? In educational settings information transfer take priority over aesthetics. Tinker and Paterson's work is extremely basic. It is not creative, it is not adventurous. It is conservative and solely based on a search for predictability.

Publishers can use this information to respond to pressures for verification of selection of optimals for publication of school materials. This information can easily be integrated into present-day sales strategies. Tinker and Paterson's work does **not** imply a lack of other alternatives. It simply establishes certain basic parameters which work for readers.

Use of Tinker's Work Today

Today the supply of "practitioners" has exploded. With computers impacting business and education throughout America, the need to choose typography wisely is increasing as machines and software increase in sophistication. The most obvious arena is that of desktop publishing. With the rapid expansion of interactive video software and increasing screen resolution, an increasing number of typographic choices will be available when designing screens as a part of interactive programs. Customizing applications has become a viable alternative for all computer users, a population largely untrained in typographic choices.

Among beginning art and design students, selection of bizarre type styles in an attempt to express creativity is common. This same tendency is apparent in today's desktop published materials. While judgment improves with experience, short-cutting this "creative" stage on the part of those producing materials for instruction is desirable, if only for the sake of those receiving the materials. Experience teaches that selection of type is a delicate art form of its own, and beginners soon abandon "creative" choices when they realize this. There are presently millions of new "designers" in possession of computers who have no knowledge upon which to base choices. Tinker's work offers basic guidance. It offers what typographers already know but are too busy to teach millions of new users.

The effects of dealing with transmitted light (as on computer screens) rather than light reflected from paper is a new issue which

might profit from drawing on Tinker's work. A two-dimensional surface is still presented to a viewer, who is certainly also a reader. How might Tinker's discoveries be affected by this change in medium? This is the kind of question modern researchers are attempting to answer (Hartley, 1987). If Tinker were here he would most certainly be pursuing like questions, cheered on and assisted by the ever-dynamic Donald Paterson who would be independently pursuing vocational applications of the new technology.

Computers provide a whole new arena for investigation and application of Tinker's work -- not only the research completed with Paterson, but also his studies on illumination and eye movements. Unfortunately, these areas are beyond the scope of this investigation. The thousands of people involved in interactive video, computer assisted instruction, computer graphics, and an increasingly endless series of variations on these themes bring new considerations to potential research on study of various aspects of processing type. In the case of computer screens, navigation/wayfinding considerations add another factor to this equation.

One problem to which Tinker's work might contribute is study of health complaints by users which were reported in TV news bulletins (NBC News) concerning data released by Kaiser Permanente health agencies during the month of July, 1988. One of these complaints was of neck pain on the part of users. Tinker found that reading takes place more efficiently if reading material is held at a 90 degree angle to the line of sight and at 45 degrees to a table (at a distance of 14 inches from the eyes (1954, 1956).

No one tries to read books held vertically since this would force us to hold our necks at a cramped angle, yet computer screens are often vertical to table surfaces. Neck complaints are easy to understand under these conditions. Aside from physical discomfort, Tinker found that reading speed is slowed. If Tinker's work was more commonly known, perhaps computer screens could have been designed from the beginning at a 45 degree angle from the line of sight of the user. Presently computers are being designed with screens which lean toward this prescribed 45 degrees. They must also be lowered in order for this 45 degree angle to be ergonomically correct.

A recent magazine article in Newsweek (Rogers and Sandza, 1988) showed a picture of a classroom with computers lowered into desks and screens angled for easy reading. Tinker would approve.

Another set of factors based on Tinker's work which might assist in modern research on computer screens are those relating to

color and illumination. As we saw in the type manuals, greater contrast allows more efficient processing. As previously indicated, modern computer screens do not offer the same kind of light as studied by Tinker, opening a whole new area to investigation. Transmitted light logically has a different effect on the part of the reader. Complaints of eye fatigue are common among computer users. Tinker attributed eye fatigue to too-high light levels in his illumination studies. Perhaps computer screens are too bright. Guidance from Tinker's work may be useful.

As this sort of study was of interest to Tinker, we can imagine that he would consider this a valuable area of study today, building on his previous work, work which allows present researchers to build on a respected line of inquiry already established, but forgotten over the years. There now exist a whole new set of applications for this work which were not previously available.

Indications from current journals such as Educational Communication and Technology Journal (Hartley, 1987, Morrison, 1986, 1988) indicate that researchers are seeking techniques to study typography and aspects of computer use. Desktop publishing has established a strong need for guidelines.

It is plain that not only has a new audience for Tinker and Paterson's work been established, but a new demand has been created for research on a new medium in which there are potential applications of that work. It is therefore appropriate to re-present this work to a new audience who will benefit both from present knowledge and from building on this work in future investigations. The concept of the Zone of Optimal Typography provides a framework within which to view of this body of work and to which future applicable research might be added.

Today new technologies call for the application of Tinker's research results, a call which did not exist in his own time. Simultaneously, an audience now exists which did not exist in his own time. It is believed, therefore, that Tinker's work was ahead of its time, a time which has now arrived. In fact, Tinker's work is needed more now than any time in history due to this large new audience.

The difference between today and yesterday is the ability and need to use the results by an audience which did not exist a half a century ago. Tinker's work is as applicable and valid today as it was in its own time. As long as letters are processed in groups, it will be classic, whether on paper or computer screen.

The significance of Tinker's work relates to two historical periods. The first, an analysis of the time in which it was completed and the second, relevance to today's needs. Both have been accomplished. Tinker's work, with and without Paterson, became lost because it was presented to and rejected by one audience which did not understand its purpose, and to another which could not directly utilize the results in other than a monitoring posture.

Tinker believed that typographical presentation and all its physical variables determined efficiency of reading and he found differences in processing via eye movements and speed of reading in response to these variables. This, along with his duties at University of Minnesota, took up 32 years.

A check of Tinker's background and training revealed that he was trained at top institutions of his time with professors of the highest competance. His work was systematic, methodical, and consistant. While researchers today may wish to update methods, Tinker's work provides a model for modern investigators into parameters of type and enables practitioners to make reliable choices as to typography for optimal reading efficiency.

The next chapter will present examples of the Zone of Optimal Typography, based on Tinker's work.

CHAPTER 7

The Zone of Optimal Typography

Understanding the Zone of Optimal Typography (ZOT) revolves around the word "optimal." This word means "most desirable or satisfactory" (Merriam-Webster, 1976). ZOT consists of a set of optimal (most desirable) conditions under which typography can be perceived by a reader. These optimal conditions include typographical factors, figure-ground organization and contrast, lighting, ergonomic and other conditions.

The term "typographers" refers generally to those who are responsible for selecting type. This includes those whose jobs are solely working with type, but *for purposes of this discussion* also includes publishers, printers, designers and even teachers, who are responsible for deciding which type will be used in a given situation. While a typographer is usually a specialist, this group will be referred to as "professional typographers". Non-specialists who make design decisions are included here in the general term for efficiency of expression, regardless of occupation. The reader is cautioned that, outside of the ZOT discussion, "typographers" refers to typographical specialists and is used here solely for expediency in reference to the person who selects the type.

"Typography," for purposes of this discussion, refers to conditions under which the type is received as well as the image itself. These conditions have a direct impact on the speed of perception of image in the reading process and therefore cannot be separated from it.

While typographical aesthetics are desirable, they alone are not sufficient reason for transfer of information, in the form of reading, to take place. A reader reads to obtain information. The easier typography is to perceive, the faster typographical imagery can be decoded and the faster the message carried by typography can be received. Therefore, conditions under which type can be read most quickly are the most desirable, while those which slow readers down are undesirable when information transfer is the goal.

If typographical and associated conditions are "most desirable" they are within the "Zone of Optimal Typography", which is identified by a range of limitations, mostly numerical, which designate its boundaries. Undesirable factors which slow the reading process are outside of this Zone.

Tinker spent 32 years establishing a range of factors through basic research which he referred to as "readability" factors, but he never developed a theoretical structure to explain ramifications of his results. Researchers today (Groner, McConkie and Menz, 1985) continue this quest, still without designating a theoretical construct within which their findings can take shape.

Justification for ZOT includes considerations of requirements and limitations of visual systems (nature) as well as lifelong training received in educational institutions (nurture). Detailed analysis of the visual system will not be reviewed in this paper and is not necessary for a description of ZOT. While the eye has limitations, ZOT assumes average visual capacity on the part of the reader and normal function of neurological systems.

If legibility in the sense of perception of typography were an issue, basic perception would be a consideration as it was early in Tinker's work. Perception at this basic level was abandoned because of a need to assess performance of the reading task, not simply perception. Tinker abandoned the study of the basic perception of letters by the time he began working with Paterson on the Journal of Applied Psychology series (1928-1936). He undoubtedly realized, with Paterson's agreement, that perception at that elementary level was insufficient for understanding of readers and the reading process.

The term "readability" was originally used by Tinker and Paterson in reference to information in their book How to Make Type Readable (1940). They began using the term readability in reference to reading performance under varying circumstances, always involving typography.

When "readability formulas" appeared in the late 1940's (Gibson & Levin, 1979), Tinker's basic research, with and without Paterson was having limited impact on reading research. Few psychologists had access to print production facilities or the skills or equipment necessary to set type. Analysis of reading ability level through "readability formulas" became an influentical concept, while Tinker and Paterson's approach did not. Realizing that the battle to maintain the integrity of his original term was lost, Tinker reverted to the use of the term "legibility" although he did not feel that it accurately described his work (Tinker, 1963).

Tinker defined legibility as:

> "coordination of those typographical factors inherent in letters and other symbols, words, and

connected textual material which affect ease and speed of reading."

The Zone of Optimal Typography (ZOT) extends this definition to include conditions under which typography is perceived, which comprise virtually all of Tinker's work.

A reader sees black images on a white background. In standard printed materials an image (single or group of letters) either exists or it doesn't. There is no attempt at subtlety through use of varying greys, colors, or odd shapes. Those variables are tools of the world of graphic design, design to create visual interest. Standard reading situations require transfer of information. In this sense, the reader is best offered visually passive typographical imagery which does not distract, encumber, or slow readers. On the other hand, typographers know that simply selecting standard type is not the only consideration. Aside from type itself there are other factors which must be addressed, such as white space, line length, layout, etc.

Efficient perception of typography depends on an interaction between 1) the typography itself, 2) conditions under which it is presented, and 3) experience and ability of the reader. While the last two are heavily reliant on actions of the consumer, the first is not. This is the area of special interest with regard to materials designed for reading. However, since the latter two factors are important in the overall process, Tinker did not ignore them. He included study of typography appropriate for young children (development of experience and ability) and ergonomics (conditions under which it is presented) in his basic research.

Tinker and Paterson found that typographical conditions offered by the typographer made a significant difference in the efficiency of processing by readers. Tinker saw reading as a wholistic experience (1965). He looked beyond direct typographical factors toward the conditions under which it took place and pursued research in illumination and eye movements. If the type was giving the reader problems, he wanted to "see" how these problems were evidenced by monitoring eye movements, thereby monitoring specific difficulties of the eye in its quest to accurately perceive typography. Sometimes it regressed too often (white type on a black background), other times it fixated too many times (too large type) or it may have paused for excessively long periods (low light levels or too small type).

Research on imagery draws upon two sources. One is internal imagery, the other external. Tinker was concerned with external imagery, how it was input, matched with internal imagery

and processed by recipients. Since typography is the most common academic imagery learned by children and type is an important form of communication for testing and interpreting ideas throughout school days, it seems obvious that quick perception of this form of imagery would be essential to academic success. An image which has been seen often will logically be more readily perceived than one which is new. However, even among common imagery, some forms are more readily perceived than others. Typographical imagery carries the same information whether type is presented in Scotch Roman or Cloister Black, yet one is more quickly perceived than the other (Tinker, 1932). The cause for this may be practice or it may be perceptual limitations such as difficulty in discrimination. Human beings read type fastest which provides the least challenge, whatever the cause. Scotch Roman should be selected before Cloister Black when designing basic reading materials because it is processed more quickly, providing faster access to information.

Debate over the evolution of typography might resemble that of nature vs. nurture. Optimal typography has been selected intuitively by some professional typographers for many years. Have they instinctively selected type which is easier to read (commonly used type faces within ZOT) or did readers simply adapt to technological capabilities? In this sense reasons for Tinker's results might be debated. Was he finding limitations of the visual system or did he merely record what people became most used to seeing? This debate, while applicable to the Zone of Optimal Typography, will not be conducted here, though it is recognized as being a valid arena for argument and future research. The point is, no matter what the cause, Tinker's work does take structure within this theoretical framework and provides guidance.

Professional typographers, it is believed, know many of the limitations of the Zone well. Much of Tinker's work showed the truth of that knowledge. Our need today does not primarily revolve around changing professional typographers' decisions, unless those typographers happen to be making erroneous decisions. It is plain that many in this profession are already making good decisions without studying scientific research. It is also apparent that some are not (educational materials given to me to use with high school students). Verification of research is helpful, especially for non-professionals, less experienced materials designers and those who seek to discover reader needs.

The needs this section seeks to satisfy are several. First, typographers in general can use Tinker's (and later) work to validate decisions they make based on scientific research rather than trying to explain truth arrived at through intuition. These decisions may be valid, but they gain strength through demonstration.

Second, plainly, desktop publishing is becoming increasingly commonplace, with a new population of inexperienced users making decisions with little understanding of the impact on the receiving audience. In the case of flyers, commercial products, etc., this is not too serious, but in educational situations this is most undesirable, especially within school systems, where it is plain teachers will be preparing materials for their students. Software with built-in defaults prepared for educational packaging would help, but presently there is no evidence of this approach in the desktop publishing industry.

Third, while designers need this information for similar reasons to those above, for them the application is restricted to a small portion of their overall plan. While visual passivity is the antithesis of the designer's goal, it is helpful for this aspect of typography, efficient transfer of information as a reading task, not for visual stimulation, to be included in the overall repertoire. This does not rule out "activating" design choices as part of an overall strategy within the total educational package, which is most desirable.
For accomplished readers who select a book as much for its intriguing design as for reading its content, ZOT is insignificant.

Designation of any parameter as within or outside of ZOT depends on what the visual system needs or how efficiently it is able to function. Most of Tinker's work involved normal reading situations. When Hubel and Wiesal discovered "edge detectors" (1979) an understanding of the fine discrimination abilities of the visual system increased. The eye integrates a massive array of visual input simultaneously, and typography is an array of edges. Plasticity of the visual system is continually being investigated as researchers discover new keys to brain malleability, especially in the visual system (Aoki and Siekevitz, 1988). These and other discoveries aid understanding of neurological aspects of ZOT.

Tinker was an experimentalist, conducting well over 100 basic experiments related to ZOT/conditions of reading. As Director of the Experimental Laboratory at the University of Minnesota, now named in his honor, he was a hard and consistent worker. While it would have been most logical for him to develop a theoretical statement

when he was retired and had time to contemplate the ramifications of his work, the fact remains he did not. Demonstration that there exists a set of conditions comprising a Zone of Optimals is a purpose of this work. Full interpretation is in the future and must include work completed since Tinker's time.

Typography is a most basic tool of life in modern society. Understanding conditions needed by children in the development of reading abilities and possibilities for development of literacy by adults are certainly crucial to our ability to offer these conditions when literacy (and the lack of it) remains a vital concern.

Research on brain development has revealed a connection between neurological development and visual development. Speculation in relation to developmental typographical needs is irresistable. Research with cats has shown that there are periods of optimal development of particular visual systems. For instance cats who do not see vertical lines within a certain span of their neurological development are forever blind to vertical lines (Hubel & Wiesel, 1979; Aoki & Siekevitz, 1988). Might there be some correlative factor in reading? Research has demonstrated that reading patterns are formed by grade 4 (Gibson & Levin, 1979, Taylor and Taylor, 1983). What if there exists some typographical conditions presently being presented to children via basal readers which slow their reading, discouraging some with limited ability to translate the typographical message? We see in speech development that post-pubescent language learning is accompanied by accents which are nonexistant in pre-pubescent linguistic development (McNeill, 1970). Might learning disabilities be influenced by poor early typographical imagery presented to encumbered visual systems which might be better served by another set of conditions than those chosen by publishers of the state adopted text? Research is needed to answer these questions.

Tinker noted (1958) that eye movements have proven resistant to change. He also clearly demonstrated the influence of typographical variations on eye movements, especially cumulative effects of marginal factors. Might inefficient eye movements be caused by nonoptimal typography which, once established, resist change? While the effects of proper teaching methods must have their effects, if basic typographical guidelines exist which are simply followed by modern publishers, one significant factor -- optimal typographical conditions -- can be addressed and chosen so that

adverse effects of nonoptimal conditions can be eliminated as a possible cause of reading deficits.

An unpublished study (Sutherland, 1987) of basal readers used in California produced evidence that readers were approved on the basis of content, not of typographical factors. No monitoring appeared to exist which correlated basal reader use with development of ability to read on the part of beginning readers. What if some basals use nonoptimal typography which produces less able readers? Tinker's work clearly shows that typography influences eye movements and reading speed. We presently, apparently, have no way of analyzing this one way or the other.

This study also found typographical variation among McGuffey Readers, the Alice and Jerry series, and Houghton-Mifflin basal readers ranging from 10 to 64 pts. from grades primary/ kindergarten to sixth grade, with a trend toward use of larger and larger type over time, noted by Tinker and seen in his work. If use of basal readers is not monitored with regard to results, on what basis were these changes decided? Fashion? Hardly a scientific approach to selection of conditions for reading. This lack of monitoring of basal reader typographical imagery might or might not affect reading ability. The problem is, we do not know. No studies offer an answer to whether the typographical imagery used in these readers "works" (is effective), yet Tinker obviously found zones within which the task of reading can take place relatively unencumbered. Therefore, the development and use of such a Zone of Optimal Typography is overdue.

Tinker and ZOT

It is apparent in this review that Tinker demonstrated limitations in the form of numerical minimums and maximums, used here to define ZOT. It is also apparent that the Zone of Optimal Typography exists in the form of limitations which define optimal conditions. Tinker was still conducting basic research in this area when he retired. Perhaps he never stopped, in his search for optimals, long enough to survey his work as a Gestalt, formed from the segments he had investigated for so long. In his 1963 review of his own and others' work Tinker might have produced something like ZOT. While his demonstration of typographical limitations was sufficiently extensive to make such a proposal, he did not.

Perhaps he was too close to his own work. One reason he may not have seen his own unspecified theory is that he spent so many years closely involved with Paterson, an extremely influencial

personality who did not complete work for the Ph. D. Whether completion of this work would have inclined Paterson toward theory is speculative. Paterson was not a theorist. He was an applied psychologist who believed in taking direct action with knowledge from research. He was primarily concerned with practical need and application.

He was satisfied with his level of accomplishment and did not strive for more national recognition than he achieved. Perhaps he was too satisfied. Perhaps a higher level of ego involvement would have resulted in increased participation in the theoretical arena as a means of enhancing his reputation. Then again, perhaps he was just too close to his own work to focus on the big picture.

The fact that Tinker did not develop a theory does not preclude one being developed today through a survey of his work and the evidence it so plainly presents. Modern theorists continue the search for ZOT that Tinker began. While Menz and Groner (1985) refer to "optimal display conditions for reading", a unifying statement about typography needs to be made. This dissertation seeks to provide such a statement in terms of research stemming from Tinker's early work and begin formulation of a structure within which modern work might be organized.

Tinker's search demonstrated physiological and environmental constraints under which the ability to read develops and occurs unencumbered. The job remaining in development of the Zone of Optimal Typography lies in the creation of theoretical design principles within its framework. The following pages demonstrate and describe ZOT graphically according to Tinker's work.

From: How to Make Type Readable (1940)
Legibility of Print (1963)

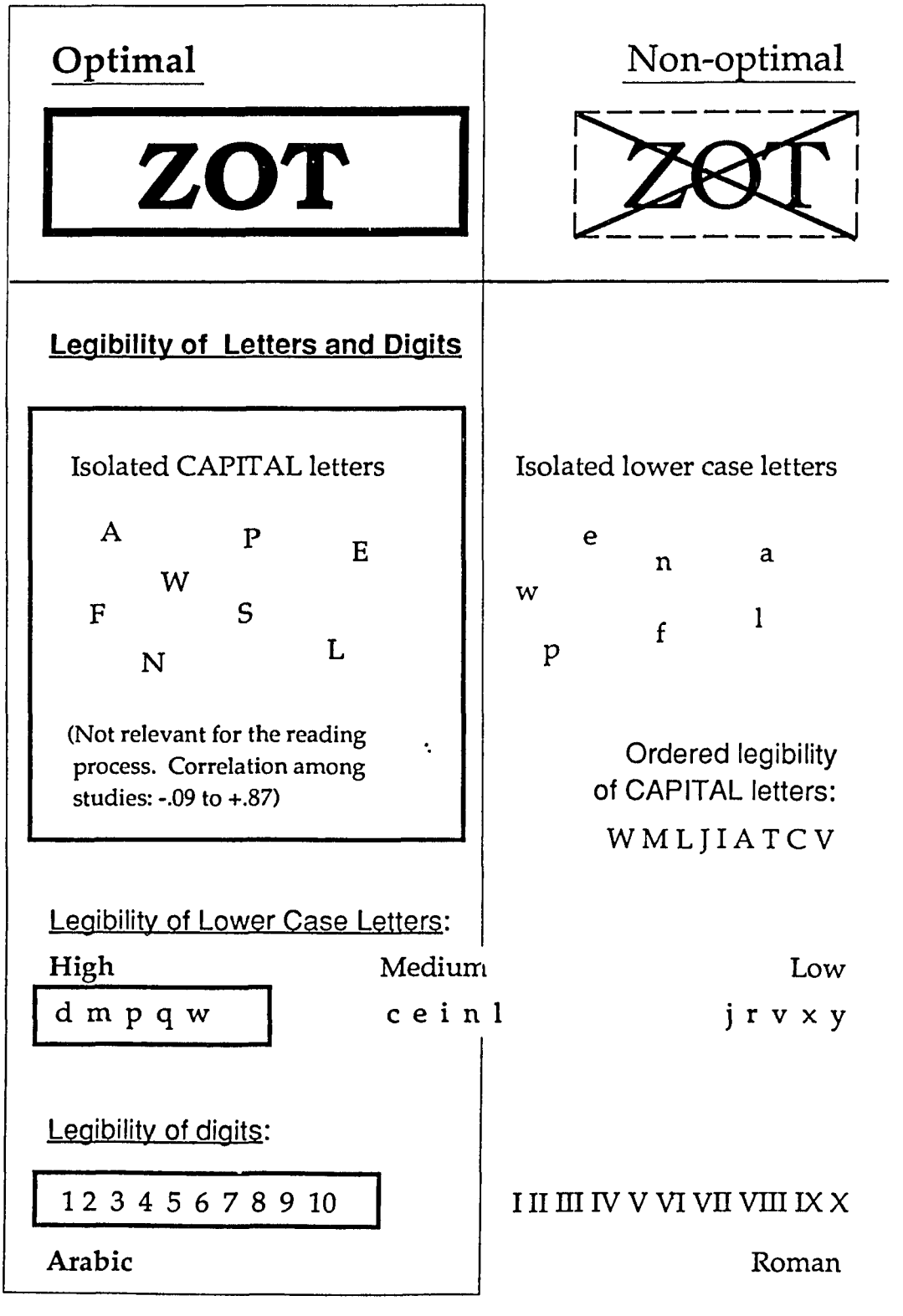


Figure 2 - The Zone of Optimal Typography

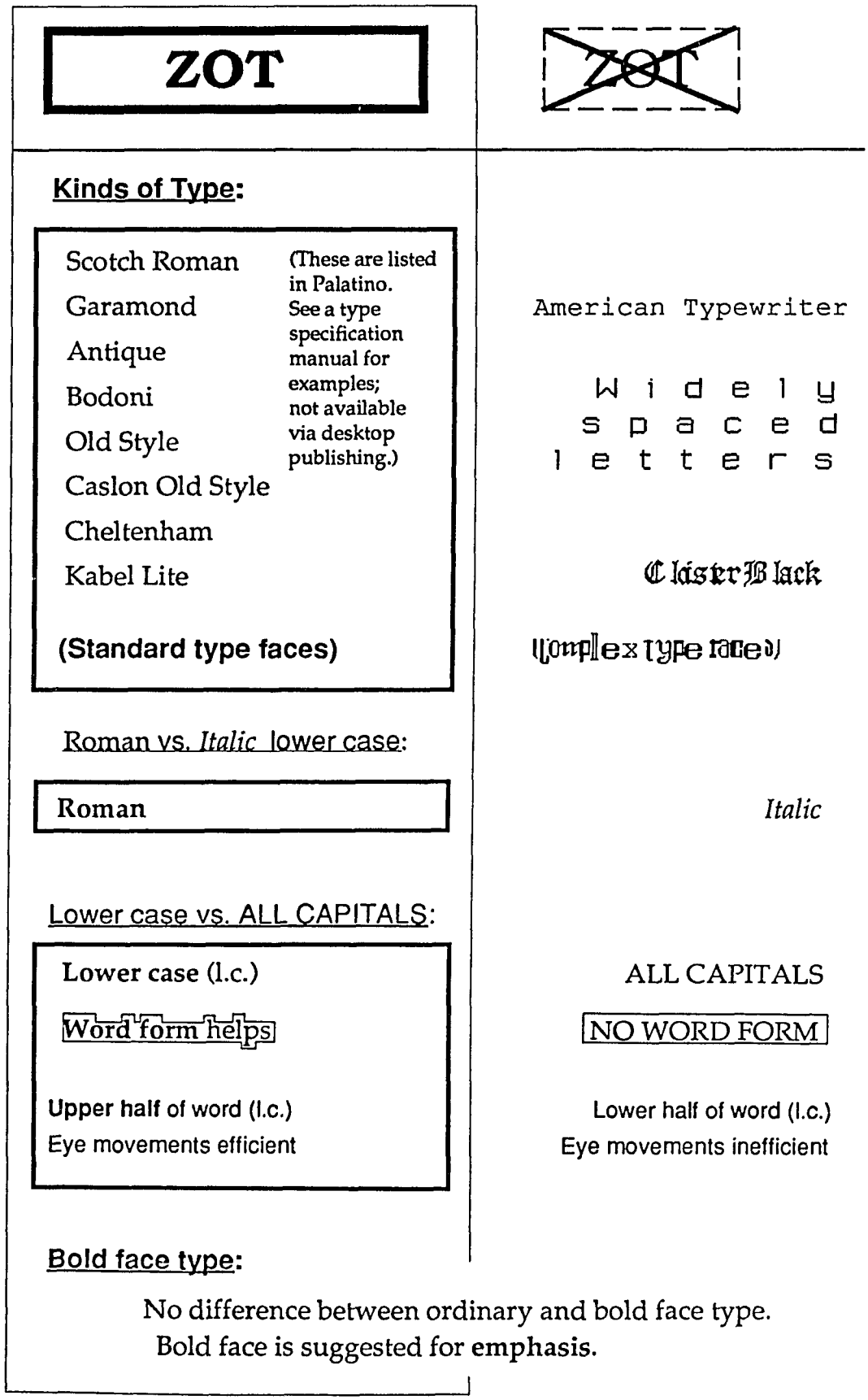


Figure 2 (cont.)

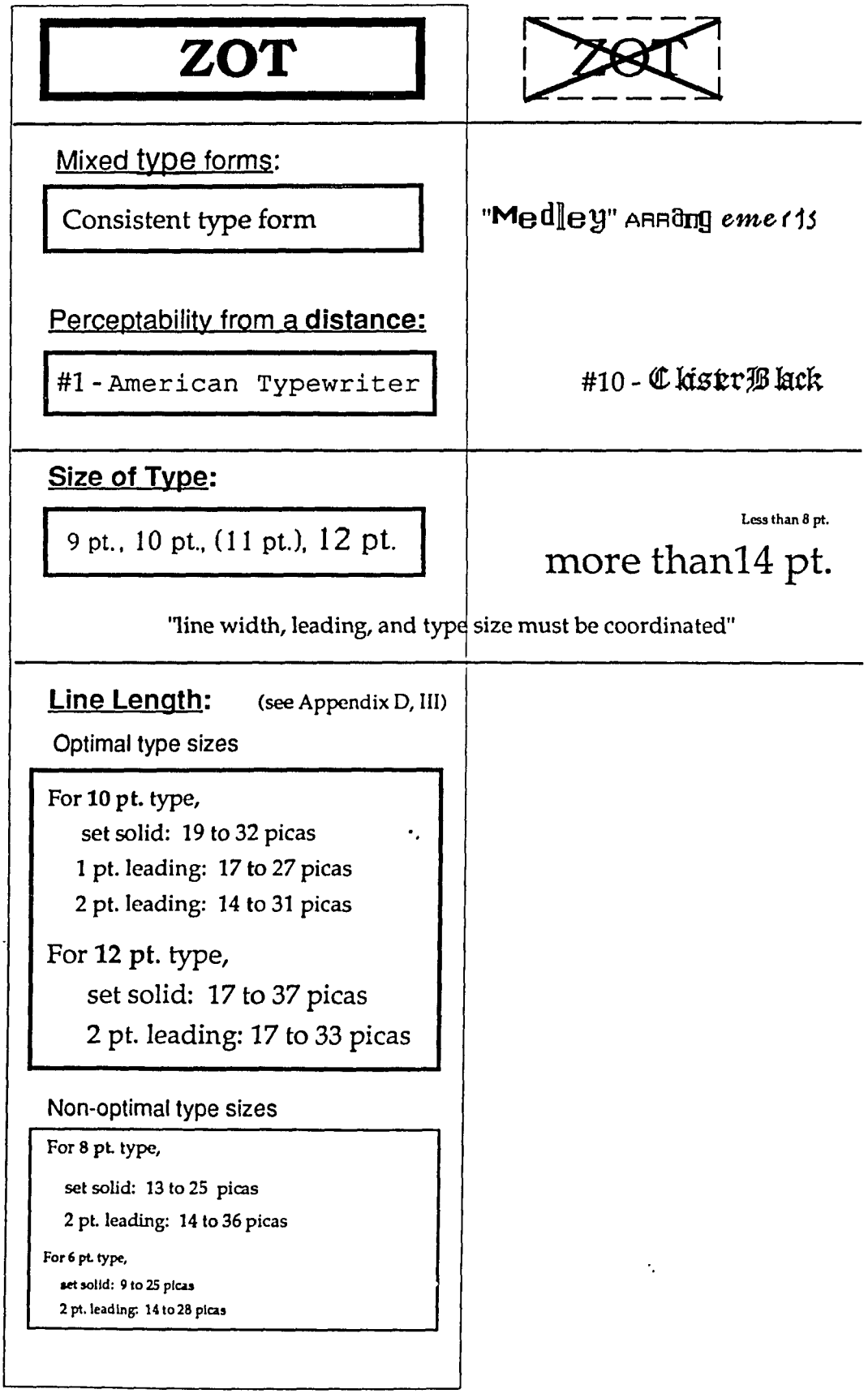
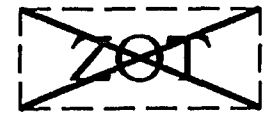


Figure 2 (cont.)



Simultaneous variation of type size and line width:

8 pt., 17 picas
10 pt., 19 picas

6 pt., 16 picas
12 pt., 23 picas
14 pt., 27 picas

Leading or Space Between Lines: (see Appendix D, VIII)

1 to 4 pt., depending on type size and line length.

Set solid
(no extra space)

Safety Zones for Leading:

Optimal type sizes:

Line length	9 pt. type	10 pt. type
14 pica	2-4 pt. leading	1-4 pt. leading
18 pica	1-4 pt. "	--
19 pica	--	2-4 pt. "
30 pica	1-4 pt. "	--
31 pica	--	2 pt. (marginal)
	11 pt.	**12 pt.**
16 pica	1-2 pt. leading	--
17 pica	--	1-4 pt. leading
25 pica	leading optional	leading optional
33 pica	--	1-4 pt. leading
34 pica	1-2 pt. leading	--

Non-optimal type sizes:

Line length	6 pt. type	8 pt. type
14 pica	2-4 pt. leading	2-4 pt. leading
21 pica	1-4 pt. "	2-4 pt "
28 pica	2-4 pt. "	1-4 pt. "
36 pica	---	2-4 pt.

Figure 2 (cont.)

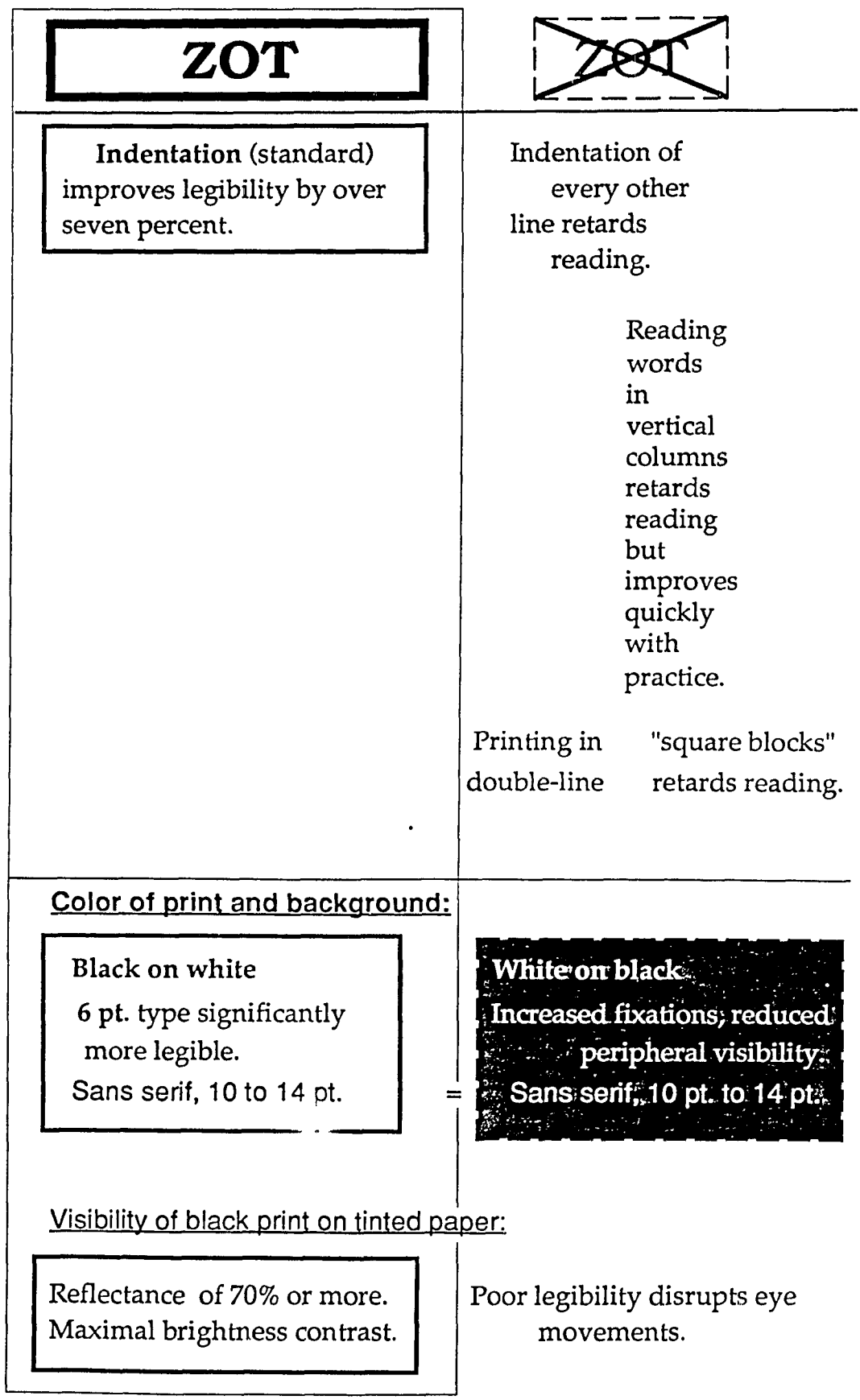


Figure 2 (cont.)

ZOT	
Printing surfaces:	
Rough or smooth surface makes no difference	Flint enamel (extremely glazed)
Cumulative effects of non-optimal combinations:	
No positive effects for non-optimal combinations	Combining two or more nets progressive loss of legibility. Eye movement patterns are severely disrupted
Newspaper typography:	
7, 8, and 9 pt. type Leading has no effect on 8 pt. type, 12 pica line length, but does help when line length is 18 picas.	Leading has no effect on line lengths over 30 or under 6 picas. 7 and 8 pt. type in optimal arrangements are less legible than 10 pt.

A survey of newpapers from 1935 to 1942 revealed standard newspaper type sizes as 7 to 8 pt. Modern newspaper type is commonly 9 pt. (San Diego Tribune, Daily Oklahoman)

Layout:

Whole-part proportion illusion – Covering 50% of the print surface appears as 60% coverage or more (modal estimate - 75%)

Curvature of the printed page reduces legibility, necessitating **wide inner margins** or gutters for optimal efficiency in reading typography.

Readers prefer a **dull surface** and dislike glare.

Figure 2 (cont.)

ZOT	
Formulas and mathematical tables:	
8 pt. slightly more legible than 6 pt.	Exponents and subscripts are less legible.
Grouping numbers by fives (best) or tens assists legibility	Letters are less legible than numerals.
Columns separated by a 1 pica space or a 1 pica space plus a rule.	Letters used most commonly are the less legible members of the alphabet.
Print base numbers in **bold.** Use numerals, (less space). Reader will group items into reading units. Modern and Old Style letters are equally legible in formulas.	Excessive complexity of charts should be avoided: the higher the number of columns, the greater the loss of legibility.
Distance from eyes:	
15 inches	
Angle of reading plane:	
45 degrees from the table, or, perpendicular to line of sight. A flat reading surface to minimize print distortion.	

Figure 2 (cont.)

ZOT

ILLUMINATION:

20 to 30 foot-candles, **diffused** light.
Minimum: 3.1 foot-candles with visual adaptation

Brighter light in non-optimal situations, "few reading situations require 50 foot-candles"

With adequate brightness contrast, between 5 and 400 foot-candles.

Less than .60 brightness difference requires brighter illumination.

Older people who use bifocals need brighter light levels.

Source of light is insignificant.

ZOT

Illumination Guidelines:

Intensity	Foot-candles
Sustained reading of optimal typography:	**15 to 25**
Schoolroom illumination:	20 to 30
Sustained reading of small print:	25 to 35
Casual reading of standard book print:	10 to 15
of smaller type:	15 to 20
Print of medium low visibility (.40 to .55 brightness contrast):	35 to 50
Print of very low visibility: (unlikely in standard home, school or library situations.)	75 to 100
Eyes with less than normal visual acuity: casual reading:	25 to 30
sustained reading:	35 to 40
Sight-saving classes:	50 to 60

Figure 2 (cont.)

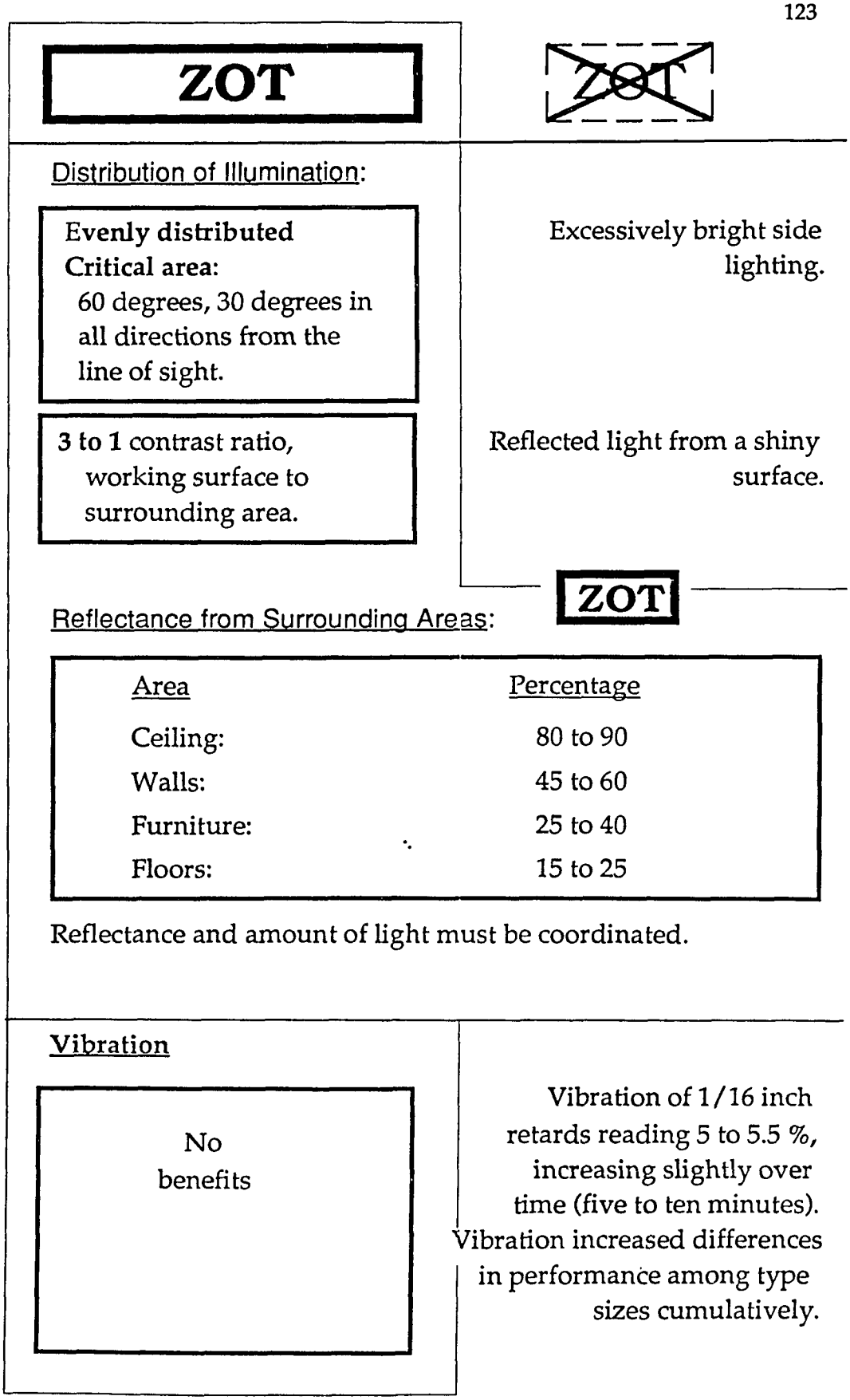


Figure 2 (cont.)

ZOT

ZOT Typography for Children

	Point size	Leading	Line Length
Grade 1	14 to 18 pt.	6 to 8 pt.	20 picas
	(Tinker recommends one sentence per paragraph)		
Grade 3	12 to 14 pt.	3 to 4 pt.	< 36 picas
Grade 6	10 to 12 pt.	2 pt.	17 to 37 picas

By sixth grade, children are able to read adult typography.
Young children:
No heavy or long serifs. No too-thin hairlines nor thick lines in the centers of letters.

ZOT

Reader opinion/preference:

Kinds of Type:

#1 - Cheltenham
#6 - American Typewriter

#10 - Cloister Black (last)

Serif

Sans serif

Types bordering on bold face, (but not bold face.)

11 pt.

Figure 2 (cont.)

Reader preferences (cont.)

Moderate line lengths,
i. e. 10 pt., 19 picas.

Short -- < 14 pt. (approx.)
Long -- > 37 pt. (approx.)

Ample margins
Double columns
Readers preferred --
1) a rule + 1/2 pica, ea. side
2) 1 pica
3) 2 picas.

No difference in speed of reading whether margins are large or small. Columns separated by 1/2 pica, 1 pica, 2 pica, a vertical rule with 1/2 pica or 1/4 pica, no extra space on either side were all read equally efficiently.

10 pt. book print.

6 pt. type:
Very short
and very long lines were disliked.

Readers prefer:

1) 8 + 9 pt. type, 2 pt. leading,
12 pica line length (newspaper).
2) 9 pt., 2 pt. lead, 18 pica line,
3) 8 pt., 2 pt. lead, 18 pica line,
4) 7 pt., 2 pt. lead, 12 pica line.

Tinker recommends:

1) 8-9 pt., 2 pt. leading and 12-12 1/2 pica, **newspaper** type.
2) Use of word form cues for reading from a distance.
3) Size reduction of no more than 80%.
4) No medley arrangements.

Reader lighting preference was near the present level of adaptation.

Figure 2 (cont.)

CHAPTER 8

Denouement

This dissertation has described Tinker's research and its applications by surveying the character of its author and his contemporaries. It has also provided visual illustrations of the factors Tinker researched in a form the original work did not and has assembled a complete bibliography of his work. A survey of literature which might directly utilize Tinker's work demonstrates that it was not applied nor even widely cited. An audience with new technological power awaits guidance from this and other work for design of educational materials.

Primary documents and interviews with Tinker's son Gordon indicate that he was happy with his work, his career, and his professional situation. Tinker provided his own modest view of his work and career, nine years before he retired. In a letter to E. G. Boring dated May 17, 1950, he wrote about his days at Clark and after:

> "I was thrilled and greatly motivated by that period. As I look back on my sparse knowledge and mediocre accomplishement at that time I wonder that you or anyone else could sense that I would accomplish anything. And again it was you who helped me to get located at Stanford after my stomach operation.
>
> Furthermore it was your stimulation that motivated me to frequent publication. After that, I of course owe much to Dr. Miles at Stanford and to the encouragement of Mike and Pat here at Minnesota."

In three shorts sentences Tinker revealed, a humble view of his own work:

> "Of course, I do not mean that I have accomplished a great deal. I believe that I have a realistic view of my abilities and accomplishments. What I have accomplished is modest but it has been gratifying to me."

In other parts of this letter Tinker touched on things discussed in greater depth in other parts of this paper. He said that history of

psychology was always his favorite class to teach. As was family tradition, he was preparing for the summer in Massachusetts: "Although I like living here, we all prefer to vacation in New England." He noted that he was three months behind schedule completing a first draft of a textbook on reading (presumably Teaching Elementary Reading) and that the next book he had planned would be a "scholarly work on the psychology of reading (perhaps Reading Difficulties,co-authored with Guy Bond).

Looking at Tinker and his contemporaries from the end of each life is cause for reflection on three different styles of living a life.

Correspondence between Elliott and Tinker was extensive, partly due to Elliott's continued involvement with editorship of the Appleton-Century-Crofts Psychology series and Tinker's continued authorship. This correspondence, during both men's retirement years predictably and consistently discussed health concerns. Paterson's many years of drinking and smoking caught up with him, as both he and his wife suffered consistent illnesses in their later years. Tinker and Elliott discussed deaths of colleagues along with personal health reports and business affairs. They lamented changes in Minnesota psychology, the loss of carrying-on the "Paterson tradition" and the inconsistent leadership following Elliott's retirement.

Tinker

Tinker, the quiet man, retired by choice when he reached the age of 65. At the suggestion of Tinker's wife Katherine, a book of letters was assembled from students and co-workers. Patience is the characteristic that appears most often in these letters. Paterson wrote:

> "Mike Elliott reminded me the other day that I was the one responsible for bringing you to Minnesota while I was Acting Chairman and Elliott was in Asia. ...you filled the bill to the Queen's taste and I acquired a lifelong friend.
>
> ... It was one of the most interesting and amicable collaborations I have ever experienced unless it be the two years I worked with Pintner. Everyone of these thirty-two years have been made worthwhile for me by your steadfast and loyal friendship. I am deeply grateful."
>
> (Retirement letter, 1959, Paterson to Tinker, Tinker family files.)

Elliott's letter appears in two forms, one as a record within the retirement letters, the other apparently a speech for Tinker's retirement dinner, with hand written underlines for emphasis which is reproduced here:

> "You have been the historian of Minnesota psychology. It will, therefore, be no surprise to you to be reminded that, though a great many psychologists have belonged at one time or another to our department, you are only the second psychologist ever to retire from it! Some, alas, have died, some have resigned, the appointments of a good many have come to a natural end, and it is rumored that in one or two instances a stronger way of putting it may be the more correct one. But you and I have retired. Of our cases, only yours is really retirement, for at 68 I had no choice. You have chosen, and as a free man you go to live in the golden state you learned to love in student days. Your decision was quietly and firmly made years ago. It fits your character to do it this way. I grant that it is the right and wise choice. You are going both to be happy and to find a way to do something more for psychology, in the years to come, at a pace that henceforth will be more leisurely.
>
> For ourselves, and particularly for myself, I am awfully sorry to have you go. We lose three years of your supervision of the laboratory courses, a most important part of the department that throgh (sic) three decades I never had to fret about. We well know how fortunate we have been to have in you precisely the same sure tough and dedicated interest in teaching experimental psychology and producing laboratory manuals that Bill Foster, straight from Titchener, brought to Minnesota forty years ago. How proudly, also, we have followed your research programs aimed at discoverong (sic) optimal lighting conditions and the best forms of type and printing arrangement. In each of these areas you have turned out scores of papers

widely recognized for their good sense and practical value. I have been cloest (sic) to your work in the laboratory manuals and the psychology of reading and so have been gratified to note the fine response to your books. They will be in use for many years to come.

When I say that I am particularly sorry for myself that you are leaving Minnesota I am thinking how sad it is to lose you as a near neighbor. How greatly I would have enjoyed sharing with you many of the carefree hours that retirement brings! You, perhaps, would be leaning on a hoe, I sitting munching some of your produce, while we dilated upon the universe as two old New Englanders see it, reminiscing about the Minnesota that used to be, and indulging at leat (sic) occasionally, and faintly, in self-congratulations. Well, all of that can in some measure still be true, in this country where retired people travel almost as much as they stay at home. I am looking forward to it! Meantime I can only wish you and Katherine many happy years, and heap upon you admiration, gratitude, and affection."

(Typed document with handwritten emphases, attributed to Elliott. No signature. Tinker files, University of Minnesota Department of Psychology.)

Paterson

The year following this retirement tribute it was Paterson's turn to retire, like Elliott, unwillingly. Tinker wrote him a letter which began "Welcome to the 'Emeritus Club' of retired Minnesota psychologists. The membership will now be three. Who will be next?" Tinker noted that when Paterson offered him the position at Minnesota he had already turned down three offers waiting for a better one. "Your offer was it!" He recalled the first time they had met, in Rm. 209 of the psychology building as he and Elliott worked on the Mechanical Abilities manuscript.

"You have been my best and most constant friend over the years at Minnesota. I have always felt welcome in going to you for advice both professional and otherwise. Your comments were

always sincere and honest. Consequently they meant a great deal to me."
(Letter, Tinker to Paterson, April 6, 1960, Tinker family files)

Paterson wrote, in July of that year, that he liked retirement.

"I did quite well on my journals & books & will be able to live decently though not lavishly! But retirement eases up a hell of a lot of payments -- insurance, dues, etc., etc., & income taxes after next April will be drastically reduced. And I'm all for the Welfare States & the Soc. Security payments!"
(Letter, Paterson to Tinker, July 20, 1960, Tinker family files)

Paterson, the hard-driving Irishman, was the first of the three men to die, of cancer, in 1961, and Tinker reflected to Elliott his sorrow at losing a good friend. Considering the reports of Paterson illnesses, Paterson's death was expected, as reflected by a colleague:

"His son, Dr. Phil, diagnosed the illness and Pat, Margaret and Phil all prepared for an early death with their customary calm, objective appraisal of all the relevant data. ...

Just last Sunday, on my last visit to him, although under sedation, he vigorously recounted how he had, at long last, persuaded a recalcitrant professor that counseling students was, indeed, a legitimate function in our University. This was but the last of his devoted efforts to improve the lot of students through applied psychology. What a magnificent monument to this pioneer are these and the innumerable other contributions made since he came to Minnesota in 1921, committed as he has been to the "individualization of mass education" as he early described his "cause".
(Tribute to Donald G. Paterson, 1892-1961, by E. G. Williamson, Elliott papers, Walter Library Archives, University of Minnesota)

Paterson himself had said that his concern with student rights and individual differences came from his own scholastic difficulties with subjective assessment and early observation of social injustices. He became impatient with procedures based in little practical reason.

(Reminiscences Concerning Growth of Student Personnel Work at University of Minnesota by D. G. Paterson, Elliott papers, D. G. Paterson, 1959-61, University of Minnesota Walter Library Archives)

Other tributes point to other achievements.

> "Altogether Paterson spent 39 years at the University of Minnesota. His book "Physique and Intellect" sought to debunk myths of connections between physical characteristics and intelligence. He "pioneered" the Minnesota College Aptitude Test and developed the Minnesota Clerical Aptitude Test "which is still widely used as a basis for selecting clerical personnel". He founded and served as president of the American Association of Applied Psychology. As mentioned, he served as Secretary of the American Psychological Association for six years, and Editor of the Journal of Applied Psychology for twelve.
> (Mental Health Progress, Volume 11, Number 6, June, 1960.)

One of Paterson's students said, "Whenever I complete a project or review the work of others, my first thought is, 'I wonder what he would think of this.' The standards he set for us will permanently affect our lives." (Ibid.)

Richard Kleeman, a writer for the Minneapolis Tribune, wrote a tribute to Paterson which included one of Paterson's favorite stories used to illustrate his attitude toward individual differences.

> "Mr. Paterson, who died Oct. 4 (1961), always carefully credited the story to Dr. G. H. Reavis, assistant superintendent of Cinncinnati, Ohio, public school. It goes like this:
>
> THE ANIMAL SCHOOL
>
> Once upon a time the animals decided they must do something heroic to meet the problems of a "new world," so they organized a school.
>
> They adopted an activity curriculum consisting of running, climbing, swimming, and flying; and to make it easier to administer, all the animals took all the subjects.
>
> The duck was excellent in swimming, better in fact than his instructor and made passing grades

in flying, but he was very poor in running, he had to stay after school and also drop swimming to practice running. This was kept up until his web feet were badly worn and he was only average in swimming. But average was acceptable in school, so nobody worried about that except the duck.

The rabbit started at the top of the class in running, but had a nervous breakdown because of so much make-up work in swimming.

The squirrel was excellent in climbing until he developed frustration in the flying class, where his teacher made him start from the ground up instead of from the tree-top down. He also developed charlie horses from over-exertion and then got C in climbing and D in running.

The eagle was a problem child and was disciplined severely. In the climbing class he beat all the others to the tip of the tree but insisted on using his own way to get there.

At the end of the year, an abnormal eel that could swim exceedingly well and also run, climb and fly a little had the highest average and was valedictorian.

The prairie dogs stayed out of school and fought the tax levy because the administration would not add digging and burrowing to the curriculum. They apprenticed their child to a badger and later joined the ground hogs and gophers to start a successful private school."

Kleeman noted that this story had been sent him by Paterson twice, and embodied his "great concern for every individual's educational rights, abilities and handicaps." (ibid.)

Elliott had the greatest admiration, even love, for Paterson and his tribute to him upon his death does not disguise this feeling.

"Of great importance to the development of applied psychology and its professionalization is what has come to be known everywhere in psychology as the Minnesota Point of View. This Minnesota Point of View is Donald Paterson. It guided the content and method of his teaching

and research and reflected deeply rooted values and beliefs that were basic to his whole approach to life.

This Paterson-Minnesota Point of View embraces such things as: belief in, and understanding of individual difference; concern with careful research methodology; respect for the evidence; concern with facts---what has been called Dustbowl Empiricism; and, belief in the dignity and worth of the individual. ...

Since 1921, approximately 300 students have earned their M.A. degrees and 88 students have earned Ph.D. degrees with him as their major advisor. ...

Since 1914, he contributed more than 300 articles and books to the advancement of psychological knowledge; His publication rate of one publication every two months over his entire career, is rarely achieved even by the most eminent of professional persons. "
(Elliott tribute, Paterson file, University of Minnesota Department of Psychology.)

Paterson's death was certainly a great loss to Elliott because he believed in him so strongly. He wrote to Tinker of his pleasure at seeing anti-smoking campaign activity, mentioning a woman who smoked "as much for a woman as Paterson did for a man. The trouble is, the penalty is so long! Skinner theory requires that the consequences be immediate to be effective in learning."

Elliott

Elliott's health became a consistent issue in his correspondence with Tinker as of 1962, though he did not die until 1968. He remained an active editor and wrote Tinker consistently about news of Minnesota. It pained him to see "his" department undergo personnel turn-overs and inconsistent leadership. He kept track of Margaret Paterson's health, recording surgeries and illnesses. He commisserated on cataracts, recommended medicines for spastic colon, and reported on his bronchial problems.

Tinker's children visited Elliott periodically and he sent Tinker glowing reports of their good progress. He noted that Boring wrote him, lamenting changes at Harvard, both feeling that things

were not as much fun as they had been in the exciting days of the early growth of psychology. When Tinker's 1965 Bases of Effective Reading was published, Elliott was particularly pleased, calling it "The Essential Tinker, in One Volume".

On August 15, 1966 Elliott wrote of plans and progress on the new psychology building. He had finally given up his office at the University. Again he lamented the state of the department:

> "I wish I thought the morale of the department were highter. Of course the trouble is partly that it's grown so big, has so much research money from outside, and has so many men eligible for offers from outside that their suitcases are already packed, waiting for the move. " (Letter, Elliott to Tinker, August 15, 1966, Tinker family files.)

He continued reporting on Margaret Paterson's health, which continued to deteriorate. He noted that of he and his four surviving siblings, their average age was 79-1/2. Two siblings were in poor health due to strokes, "What may happen to us at that age is not tragic, because it's the law of life, but can be sad and depressing." (Ibid.)

On April 7, 1968 Elliott noted that his pulmonary fibrosis was a constant problem and asked about Tinker's eye. He reported that "Garry" (Boring) was constantly in a wheelchair now, "fighting against mellaloma", and using a drug called Alkeran, which seems to be helping. Toward the end of this letter he could not contain his excitement:

> "This week Jack Darley wrote me that he had announced at the annual R. M. E. Lecture what had hitherto been a secret. Perhaps you know it. The Regents have voted to name psychology's quarters -- present & future (when our old part of the building is torn down & replaced by one for which plans have been drawn) Elliott Hall. I am astonished at such action, & of course deeply moved & grateful. I do not -- & this is apart from my limitations, which I know -- believe the name of a living person should be honored in this way. An individual is so ephemeral. Only the dead, & the truly great, deserve it -- Wm. James, for example." (Letter, Elliott to Tinker, Tinker family files.)

On April 28, 1968 Elliott reported that Boring had died soon after a fall which his wife had reported was from "cancer softening his bones". He noted that Tinker had previously written calling Boring "a wonder", a phrase Boring himself had used to describe Elliott many years before when Tinker was first becoming involved with the University of Minnesota. Elliott says Boring's spirit was fine right to the last. "I miss knowing he is among us and will be writing soon." He reported, faithfully, that Margaret Paterson was now in a retirement home.

Finally in 1969, at age 81, Elliott succumbed to pulmonary fibrosis. His obituary quoted him as writing, "I never forget, it has been my privilege to be paid to examine the universe." It noted that he had been the founding editor of the Century Psychology Series and had been active in that work until his death. His wife Matilde wrote Tinker that Elliott's health had deteriorated markedly since catching a cold shortly after the dedication ceremony of Elliott Hall.

> "All through these last difficult months
> he never complained, though he knew, I am sure,
> as I did, that the end of the road was in sight. A
> true stoic - & a wonderful human being. How
> fortunate I am to have had these 40 years!"
> (Letter, Matilde Elliott to Tinker, May 30, 1969,
> Tinker family files.)

It is at this point that most of Tinker's closest friends and contemporaries were gone. Paterson died soon after he, with great regret, retired. Elliott died soon after the dedication of Elliott Hall. Each of these men's lives revolved around their work and each retired because he had to.

Tinker outlived both of this closest colleagues, like them, remaining active, but still living a quiet life of consulting on typographical imagery (letters from Ovink, in Holland, and others from New Zealand and Japan remain in the Tinker family files) and continuing his gardening.

Every day, from his home in Goleta, California, Tinker went for a walk of one mile. Often he visited the campus of the University of California, Santa Barbara, which was close by. For eight years after Elliott's death he continued his daily rituals. A letter to Elliot in 1964 revealed good health reported methodically. He noted he took 2 grains of thyroid, with lingering (life-long) stomach concerns being attended to through medical attention. He noted, as Gordon

mentioned was a life-long habit, that he took 1-1/2 to 2 hour naps after lunch. He wrote "I feel quite encouraged even though I need to watch digestion." He went on to describe finishing touches on Bases for Effective Reading, family concerns, and, of course, how his garden was coming along. A "P. S." reported that they were out of danger from local fires.

Two days before his death Tinker went on his customary mile walk. He fell down some blocks away from his house. Trash collectors who found him, returned him to his home. He felt better the next day, and, with characteristic perseverence, got ready for his daily walk. This time he fell at the end of the drive way, crawling back up to the house by himself.

On March 4, 1977 Tinker died as he had lived -- quietly. Computers were only beginning their impact on schools at that time and they were used predominently by those who could program them. Tinker never saw the desktop publishing phenomenon, but there can be no doubt that today he would be involved, urging optimal typography, if he could.

Memorials

Each man, Elliott, Paterson and Tinker, left his mark on the University of Minnesota. Memorials exist to two of the men. The Department of Psychology now resides in Elliott Hall, which displays a portrait of Elliott in the lobby. Tinker did not meet his classes in the modern laboratory within that facility, but a plaque was mounted above the entrance to the present day laboratory commemorating his long and faithful service. Experimental demonstrations performed by Tinker live today in the memories of ex-chancellors who were his students (Personal communication, Edward Weidner, ex-Chancellor, University of Wisconsin, Green Bay, June 17, 1988)

"Pat's" best memorial must be the long list of students he assisted through the University of Minnesota, a record standing today and unlikely to be equalled. Paterson believed in people, and no string of publications (which Paterson also had in great number) can supplant the interaction between teacher and student which rendered Paterson's legacy a living one. Judging from both Elliott's and Tinker's admiration of Paterson, one can only see Ohio State University as an unwise loser for not seeing past a lack resulting from transitional times (Paterson's lack of a Ph. D.) to the truth of his accomplishments, abilities, and worth. On the other hand, it is hard to imagine Minnesota's loss had he moved to Ohio in 1937. Ohio State's loss was truly Minnesota's gain.

The Tinker children today

As stated in the introduction, Tinker lived the American dream, from poverty to accomplishment and respectability. His children and grand-children prosper as a result.

Tinker was survived by his wife Katherine, who died in late July, 1988. He was also survived by three (now two) children, twelve grandchildren, and eight (so far) great-grandchildren.

His son Milton, a Ph. D. who died of complications of surgery in Colombia, South America, in 1983, was an internationally renowned medical entomologist who had seven children. He worked for the American Health Organization, a branch of the United Nations, studying Aedes Aegypti, a mosquito which carries yellow and dengue fevers. He set up spraying programs in Latin America and the Caribbean. Gordon says the Colombians loved Milton.

Gordon is a consulting petroleum engineer, retired from Shell Oil Co., who lives in Houston, Texas. Like his father, Gordon received his Ph. D. from Stanford. He and his wife had four sons.

Karen attended the University of California, Los Angeles (UCLA), specializing in reading. She is married to a junior college administrator, has two daughters and lives in Palo Alto, CA. She teaches reading, and visited Katherine regularly in Santa Barbara when she was alive.

In an extension of the American dream, Tinker's children have lived fruitful lives. He must have been very proud of them. His granddaughter Katrina (daughter of Milton) lived with Tinker toward the end of his life and remembers him this way:

> "Grandpa was a very nice grandfather.
> He was quiet (so was my dad) but kindly.
> ...he was friendly toward kids. There were several on the street and grandpa did things with them sometimes: not real energetic things, but I can remember him helping me fly a kite and working in the garden together. He enjoyed working in the garden a lot. He was very proud of his plants and had oranges, lemons, and peaches in his yard -- and strawberries and boysenberries. His father had a strawberry farm in New England I think. There was one girl on the street a year or two younger than me that felt that grandfather was her best friend."
> (Personal correspondence, Katrina Tinker to Sutherland, March 30, 1988, in possession of S. W. Sutherland)

Gordon says Milton resembled his father the most. Katrina described Tinker as "quiet", like her dad. John Jarolimek, a retired University of Washington professor who remembers Tinker from his University of Minnesota days, said: "If (Tinker) entered the room, you wouldn't notice. He was a very quiet, unassuming man."
(J. Jarolimek, personal communication, July 15, 1988)

A quiet gardener, who proudly sent pictures of his prized flowers to friends in Minnesota throughout his retirement years, did not live long enough to see his work come into its rightful place. Nevertheless, its value is not diminished.

Tinker's place in history

What factor might place Tinker rightfully in the company of "great men"? Not the status which accompanies a list of "firsts" (Hall), being a professor at Harvard who wrote voluminously on the history of psychology and his times (Boring), nor acting as editor for a prominent psychological series (Elliott), although these appear as accomplishments of great men in psychology. Others from Minnesota (Lashley, Skinner) became known as great theorists, which Tinker did not.

Tinker saw himself, not at the center of his own universe, but as part of the whole, and in a special place within that whole. He contributed what he had to give and stood as a facilitator upon whom others could depend. He served as audience and as mentor. While happy for accolades, he did not seek them at the sacrifice of others. He appreciated his good fortune in life and gave back as he could.

He neither sought nor achieved notoriety in his own time save within his own peer group. His reliability and humble consistancy in a pivotal position of responsibility establishes him as Great Everyman. It is time for Tinker's life's work, a significant part of it co-authored by Donald Paterson, to establish him as a great man out of his time: great because he held to his search for truth in spite of lack of acclaim. His research results provide needed and significant guidance to a world of those making typographical design decisions, especially in the field of education, 60 years after he began his work. Modern research efforts focus upon modern technology (computers) while there is a dearth of studies on traditional methods of communication (print). Rather than study how computers might be effective compared with books, we might first reassess what we know about perception of print, especially since this is the same symbol system we will likely continue to use on both screens and paper. Print came into use over 400 years

before modern statistical methods of studying human psychology. By the time modern psychology developed its metholds, print was a medium taken for granted.

What places Tinker in the company of great men is 32 years of an unwavering search for truth in how human beings process typographical imagery. He didn't do it alone, Paterson deserves a significant amount of credit for both co-authorship and influence. But it was Tinker who burned the midnight oil for interpretation of the impact of variations in typographical imagery, searching for every avenue of its understanding. He was not content simply to study typography itself. He looked at the environment in which it was presented, the layout, lighting, and plane of sight.

One wonders what Tinker would be investigating were he still alive. Surely he would be studying the new medium of computers, both as to screen resolution and desktop published typography. One can imagine him consulting with IBM and Apple on optimal typographies and bringing with him knowledge which was gained over those many years but which he may not have written down, a wholistic understanding gleaned only through many years of observation. Certainly he would look aghast at many of the products of dot-matrix printing which are far outside of the Zone of Optimal Typography, as he would marvel at the advances in this same form of print output. He would thrill to the prospects of laser printing and the new desktop publishing programs, providing an avenue to optimals for everyone. It is unfortunate that people with high level, specialized knowledge must leave us with only written remains of knowledge interpreted for their own time and inadequately interpreted for ours.

But that is one reason for this dissertation, to re-interpret Tinker with an eye to today's technology. If environment inflicts change on the human brain, there may be significant new research in simply replicating Tinker's work under modern conditions and with a population which has been brought up on larger (9 to 12 pt.) typographical imagery. This is being done to some extent (Groner, McConkie & Menz, 1985), but limitedly (effects if dot matrix printers), and this work is still having a hard time finding its way to the mainstream of typographic design.

Tinker was the pioneer in typography, eye movements and illumination, all focusing on readers and their needs. This work cannot be outdated as long as we use typography as a primary means

of communication. The weight of 32 years of work must have its effect on a population seeking guidance. Desktop publishing has created a far greater audience for Tinker's work than he himself ever imagined. It is presently a multi-billion dollar industry as typewriters are abandoned for word processing equipment and its accompanying software.

Regardless of technology, reader interaction with print and other aspects of educational materials is a more prominent topic today than in Tinker's own time. That Tinker's work is neither used nor recognized in modern texts indicates it was misplaced due to problems within his Zeitgeist over which he had no control. Today we catch up with Miles Tinker and see what Donald Paterson saw: an attention toward needs of students which is primary to their abilities to function in school and in our society.

Whether there exists an optimal time for learning to recognize typographical imagery or not is a subject for future theorists. Whether students today read within a different Zone of Optimal Typography than that of Tinker's day awaits discovery. What is certain is that Tinker found an array of factors which affected a reader's ability to process print. The search for modern Zones of Optimal Typography continues.

End Notes

Introduction (pp. 1-9)

The Tinker family files are in the possession of Clifton Tinker, San Antonio, Texas, at the time of this dissertation.

Letter, Russell N. Cassel to Miles A. Tinker, December 13, 1973, announcing Project Innovation election to the "Reading Hall of Fame. Tinker family files.

Personal correspondence, Richard A. Monty and John W. Senders to Miles A. Tinker, December 16, 1974. Tinker family files.

Chapter 1 (pp. 10-26)

Tinker family files, in possession of Clifton Tinker, San Antonio, Texas.

Interviews with Gordon Tinker took place on May 1, 6, 18, 23, and 29, 1988 at Sea-Tac Airport, Seattle, Washington. Each interview lasted approximately one hour.

Records from Clark University were acquired with the assistance of Clark University Archivist Stuart W. Campbell.

Photographs in this chapter were acquired from Miles Tinker's History files, Tinker family files.

University of Minnesota records, Tinker and Paterson files, were acquired with the assistance of Dr. Gail Peterson, Professor of Psychology at the University of Minnesota.

Psychological Register, (1932).

Chapter 2 (pp. 27-47)

Most of the information in this chapter came from the personnel files of Miles A. Tinker and Donald G. Paterson in the possession of the University of Minnesota Department of Psychology, gathered with the assistance of Dr. Gail Peterson, Professor of Psychology.

Other references are as noted.

Chapter 3 (pp. 48-58)

Most of the information in this chapter came from one of two sources:

1) the personnel file of Donald G. Paterson in the possession of the University of Minnesota Department of Psychology, gathered with the assistance of Dr. Gail Peterson, Professor of Psychology on April 22, 1988.

2) Tinker family files in the possession of Katherine Howland Tinker, Goleta, California, at the time of collection (June 25, 1988) which are now in the possession of Clifton Tinker (grandson), San Antonio, Texas. It has been suggested that these files be donated to the University of Minnesota Walter Library Archives.

Other information was gathered through interviews taking place on May 1, 1988 with Gordon Tinker in Seattle, Washington, and with Karen Tinker Strelitz on June 25, 1988.

Chapter 8 (pp. 126-140)

Letters in this section were collected from:

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Appendix A:
Tinker Bibliography

Tinker Bibliography

The Original Thirteen Studies:

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Appendix B:
Tinker Book Reviews

Tinker Book Reviews

1932

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1933

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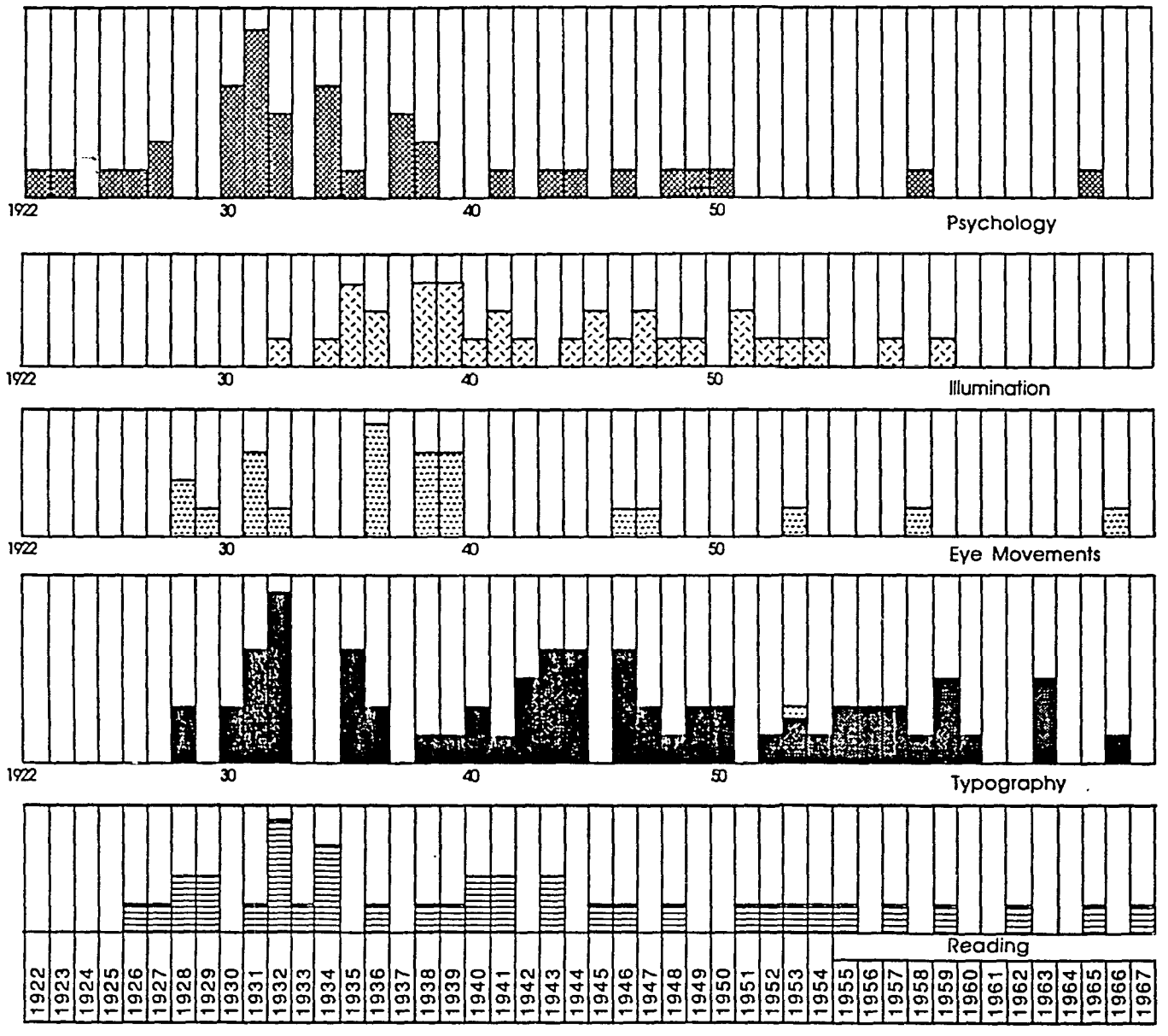
These book review references are from the Tinker family files.

Appendix C:
Timelines -- Tinker's Basic Research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Appendix D:
Visual Representations of Selected Research and Results

Tinker, M. A. & Paterson, D. G. (1928). Studies of typographical factors influencing speed of reading: I. Type form. Journal of Applied Psychology, 12, 359-368.

10 pt., 80 m.m. line length, set solid

1. THERE WAS NOT A DROP OF INK IN THE HOUSE, FOR SOMEONE HAD BROKEN THE BOTTLE WE KEPT IT IN, SO MARY DECIDED TO FINISH HER LETTER WITH A PEN. 2. YESTERDAY I WENT DOWN TOWN TO BUY SOME SHOES AND RUBBERS, BUT WHEN I GOT HOME, I FOUND I HAD FORGOTTEN TO GO TO THE FLOWER-STORE TO GET THEM. 3. THE WATER HAD FROZEN, MAKING THE ROAD AS SLIPPERY AS GLASS. IT WAS ONLY WITH THE GREATEST DIFFICULTY THAT I PREVENTED MYSELF FROM FIGHTING AS I MADE MY WAY HOME.

All Caps

Read 13.4% slower than upper and lower case combined

10 pt., 80 m.m. line length, set solid

1. *There was not a drop of ink in the house, for someone had broken the bottle we kept it in, so Mary decided to finish her letter with a pen. 2. Yesterday I went down town to buy some shoes and rubbers, but when I got home, I found I had forgotten to go to the flower-store to get them. 3. The water had frozen, making the road as slippery as glass. It was only with the greatest difficulty that I prevented myself from fight-ing as I made my way home.*

Italics

Read 2.8% slower than upper and lower case combined

10 pt., 80 m.m. line length, set solid

1. There was not a drop of ink in the house, for someone had broken the bottle we kept it in, so Mary decided to finish her letter with a pen. 2. Yesterday I went down town to buy some shoes and rubbers, but when I got home, I found I had forgotten to go to the flower-store to get them. 3. The water had frozen, making the road as slippery as glass. It was only with the greatest difficulty that I prevented myself from fight-ing as I made my way home.

<u>Read fastest</u>

A combination of upper and lower case

Paterson, D. G. & Tinker, M. A. (1929). Studies of typographical factors influencing speed of reading: II. Size of type. Journal of Applied Psychology, 13, 120-130.

all 80 m.m. line length, set solid

1. There was not a drop of ink in the house, for someone had broken the bottle we kept it in, so Mary decided to finish her letter with a pen. 2. Yesterday I went down to buy some shoes and rubbers, but when I got home, I found I had forgotten to go to the flower-store to get them.

6 point — 6.2% slower

1. There was not a drop of ink in the house, for someone had broken the bottle we kept it in, so Mary decided to finish her letter with a pen. 2. Yesterday I went down to buy some shoes and rubbers, but when I got home, I found I had forgotten to go to the flower-store to get them.

8 point — 5.2% slower

1. There was not a drop of ink in the house, for someone had broken the bottle we kept it in, so Mary decided to finish her letter with a pen. 2. Yesterday I went down to buy some shoes and rubbers, but when I got home, I found I had forgotten to go to the flower-store to get them.

10 point — Optimal

1. There was not a drop of ink in the house, for someone had broken the bottle we kept it in, so Mary decided to finish her letter with a pen. 2. Yesterday I went down to buy some shoes and rubbers, but when I got home, I found I had forgotten to go to the flower-store to get them.

12 point — 5.8% slower

1. There was not a drop of ink in the house, for someone had broken the bottle we kept it in, so Mary decided to finish her letter with a pen. 2. Yesterday I went down to buy some shoes and rubbers, but when I got home, I found I had forgotten to go to the flower-store to get them.

14 point — 6.9% slower

Tinker, M. A. & Paterson, D. G. (1929). Studies of typographical factors influencing speed of reading: III. **Length of line.** Journal of Applied Psychology, 13, 205-219.

1. There was not a drop of ink in the house, for someone had broken the bottle we kept it in, so Mary decided to finish her letter with a pen. 2. Yesterday I went down town to buy some shoes and rubbers, but when I got home I found I had forgotten to go to the flower-store to get them.

59 m.m. : 7.3% slower

1. There was not a drop of ink in the house, for someone had broken the bottle we kept it in, so Mary decided to finish her letter with a pen. 2. Yesterday I went down town to buy some shoes and rubbers, but when I got home I found I had forgotten to go to the flower-store to get them.

Standard for comparison -
80 mm line length (20 picas)

All 10 pt., set solid

1. There was not a drop of ink in the house, for someone had broken the bottle we kept it in, so Mary decided to finish her letter with a pen. 2. Yesterday I went down town to buy some shoes and rubbers, but when I got home I found I had forgotten to go to the flower-store to get them.

97 m.m. : 2.8% slower

1. There was not a drop of ink in the house, for someone had broken the bottle we kept it in, so Mary decided to finish her letter with a pen. 2. Yesterday I went down town to buy some shoes and rubbers, but when I got home I found I had forgotten to go to the flower-store to get them.

114 m.m. : 5.6% slower

1. There was not a drop of ink in the house, for someone had broken the bottle we kept it in, so Mary decided to finish her letter with a pen. 2. Yesterday I went down town to buy some shoes and rubbers, but when I got home I found I had forgotten to go to the flower-store to get them.

136 m.m. : 5.2% slower

1. There was not a drop of ink in the house, for someone had broken the bottle we kept it in, so Mary decided to finish her letter with a pen. 2. Yesterday I went down town to buy some shoes and rubbers, but when I got home I found I had forgotten to go to the flower-store to get them.

136 m.m. : 5.2% slower

1. There was not a drop of ink in the house, for someone had broken the bottle we kept it in, so Mary decided to finish her letter with a pen. 2. Yesterday I went down town to buy some shoes and rubbers, but when I got home I found I had forgotten to go to the flower-store to get them.

152 m.m. : 6.4% slower

1. There was not a drop of ink in the house, for someone had broken the bottle we kept it in, so Mary decided to finish her letter with a pen. 2. Yesterday I went down town to buy some shoes and rubbers, but when I got home I found I had forgotten to go to the flower-store to get them.

168 m.m. : 8.4% slower

1. There was not a drop of ink in the house, for someone had broken the bottle we kept it in, so Mary decided to finish her letter with a pen. 2. Yesterday I went down town to buy some shoes and rubbers, but when I got home I found I had forgotten to go to the flower-store to get them.

186 m.m. : 11.4% slower

Tinker, M. A. & Paterson, D. G. (1931). Studies of typographical factors influencing speed of reading: V. **Simultaneous variation** of type size and line length. Journal of Applied Psychology, 15, 72-78.

1. There was not a drop of ink in the house, for someone had broken the bottle we kept it in, so Mary decided to finish her letter with a pen. 2. Yesterday I went down to buy some shoes and rubbers, but when I got home, I found I had forgotten to go to the flower-store to get them.

7.4% slower

6 points, 16 picas

1. There was not a drop of ink in the house, for someone had broken the bottle we kept it in, so Mary decided to finish her letter with a pen. 2. Yesterday I went down to buy some shoes and rubbers, but when I got home, I found I had forgotten to go to the flower-store to get them.

1.6% slower

8 points, 17 picas

1. There was not a drop of ink in the house, for someone had broken the bottle we kept it in, so Mary decided to finish her letter with a pen. 2. Yesterday I went down to buy some shoes and rubbers, but when I got home, I found I had forgotten to go to the flower-store to get them.

0.9% slower

Standard Comparison :
10 pt., 19 pica line length

1. There was not a drop of ink in the house, for someone had broken the bottle we kept it in, so Mary decided to finish her letter with a pen. 2. Yesterday I went down to buy some shoes and rubbers, but when I got home, I found I had forgotten to go to the flower-store to get them.

4.1 % slower

12 points, 23 picas

1. There was not a drop of ink in the house, for someone had broken the bottle we kept it in, so Mary decided to finish her letter with a pen. 2. Yesterday I went down to buy some shoes and rubbers, but when I got home, I found I had forgotten to go to the flower-store to get them.

4.4% slower

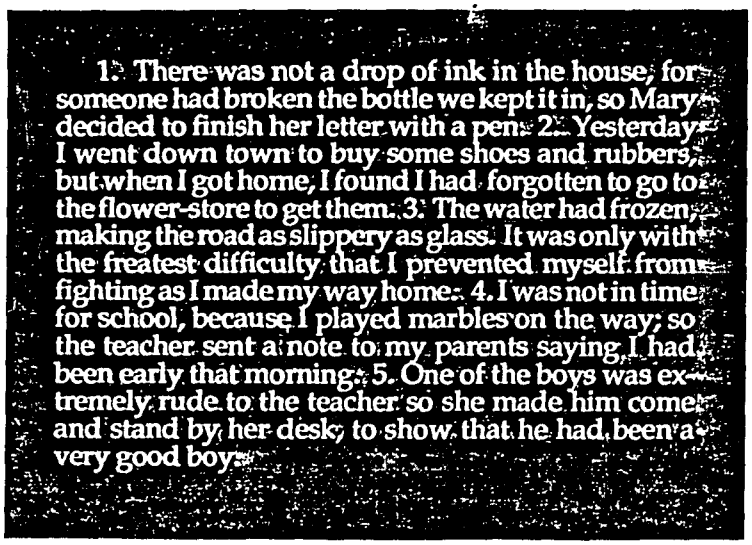
14 points, 27 picas

Paterson, D. G. & Tinker, M. A. (1931). Studies of typographical factors influencing speed of reading: VI. **Black type versus white type.** Journal of Applied Psychology, 15, 388-397.

1. There was not a drop of ink in the house, for someone had broken the bottle we kept it in, so Mary decided to finish her letter with a pen. 2. Yesterday I went down town to buy some shoes and rubbers, but when I got home, I found I had forgotten to go to the flower-store to get them. 3. The water had frozen, making the road as slippery as glass. It was only with the freatest difficulty that I prevented myself from fight-ing as I made my way home. 4. I was not in time for school, because I played marbles on the way; so the teacher sent a note to my parents saying I had been early that morning. 5. One of the boys was extremely rude to the teacher so she made him come and stand by her desk, to show that he had been a very good boy.

16.1% faster

Black on white



White on black

Paterson, D. G. & Tinker, M. A. (1932). Studies of typographical factors influencing speed of reading: VIII. Space between lines or leading. Journal of Applied Psychology, 16, 388-397.

1. There was not a drop of ink in the house, for someone had broken the bottle we kept it in, so Mary decided to finish her letter with a pen. 2. Yesterday I went down town to buy some shoes and rubbers, but when I got home, I found I had forgotten to go to the flower-store to get them.

10 points, 19 picas, set "solid"

1. There was not a drop of ink in the house, for someone had broken the bottle we kept it in, so Mary decided to finish her letter with a pen. 2. Yesterday I went down town to buy some shoes and rubbers, but when I got home, I found I had forgotten to go to the flower-store to get them.

10 points, 19 picas, 1 point leading

1. There was not a drop of ink in the house, for someone had broken the bottle we kept it in, so Mary decided to finish her letter with a pen. 2. Yesterday I went down town to buy some shoes and rubbers, but when I got home, I found I had forgotten to go to the flower-store to get them.

10 points, 19 picas, 2 point leading

1. There was not a drop of ink in the house, for someone had broken the bottle we kept it in, so Mary decided to finish her letter with a pen. 2. Yesterday I went down town to buy some shoes and rubbers, but when I got home, I found I had forgotten to go to the flower-store to get them.

10 points, 19 picas, 4 point leading

Paterson, D. G. & Tinker, M. A. (1932). Studies of typographical factors influencing speed of reading: X. **Style of type face.** Journal of Applied Psychology, 16, 605-613.

1. There was not a drop of ink in the house, for someone had broken the bottle we kept it in, so Mary decided to finish her letter with a pen. 2. Yesterday I went down town to buy some shoes and rubbers, but when I got home, I found I had forgotten to go to the flower-store to get them.	Bookman Computer type faces emulating Tinker's results. 19 pica line length, set solid.
1. There was not a drop of ink in the house, for someone had broken the bottle we kept it in, so Mary decided to finish her letter with a pen. 2. Yesterday I went down town to buy some shoes and rubbers, but when I got home, I found I had forgotten to go to the flower-store to get them.	Times Common typefaces showed no significant differences, whether serif or sans serif.
1. There was not a drop of ink in the house, for someone had broken the bottle we kept it in, so Mary decided to finish her letter with a pen. 2. Yesterday I went down town to buy some shoes and rubbers, but when I got home, I found I had forgotten to go to the flower-store to get them.	Palatino
1. There was not a drop of ink in the house, for someone had broken the bottle we kept it in, so Mary decided to finish her letter with a pen. 2. Yesterday I went down town to buy some shoes and rubbers, but when I got home, I found I had forgotten to go to the flower-store to get them.	Helvetica
1. There was not a drop of ink in the house, for someone had broken the bottle we kept it in, so Mary decided to finish her letter with a pen. 2. Yesterday I went down town to buy some shoes and rubbers, but when I got home, I found I had forgotten to go to the flower-store to get them.	Courier Typefaces challenging to the eye slowed readers down. American Typewriter slowed readers 5.1%
1. There was not a drop of ink in the house, for someone had broken the bottle we kept it in, so Mary decided to finish her letter with a pen. 2. Yesterday I went down town to buy some shoes and rubbers, but when I got home, I found I had forgotten to go to the flower-store to get them.	York Avenue
1. There was not a drop of ink in the house, for someone had broken the bottle we kept it in, so Mary decided to finish her letter with a pen. 2. Yesterday I went down town to buy some shoes and rubbers, but when I got home, I found I had forgotten to go to the flower-store to get them.	Venice Ornate typefaces slowed reading speed 16.5%. Tinker used Cloister Black

Tinker, M. A. (1932). The influence of form of type on the perception of words. Journal of Applied Psychology, 16, 167-174.

Lower case:

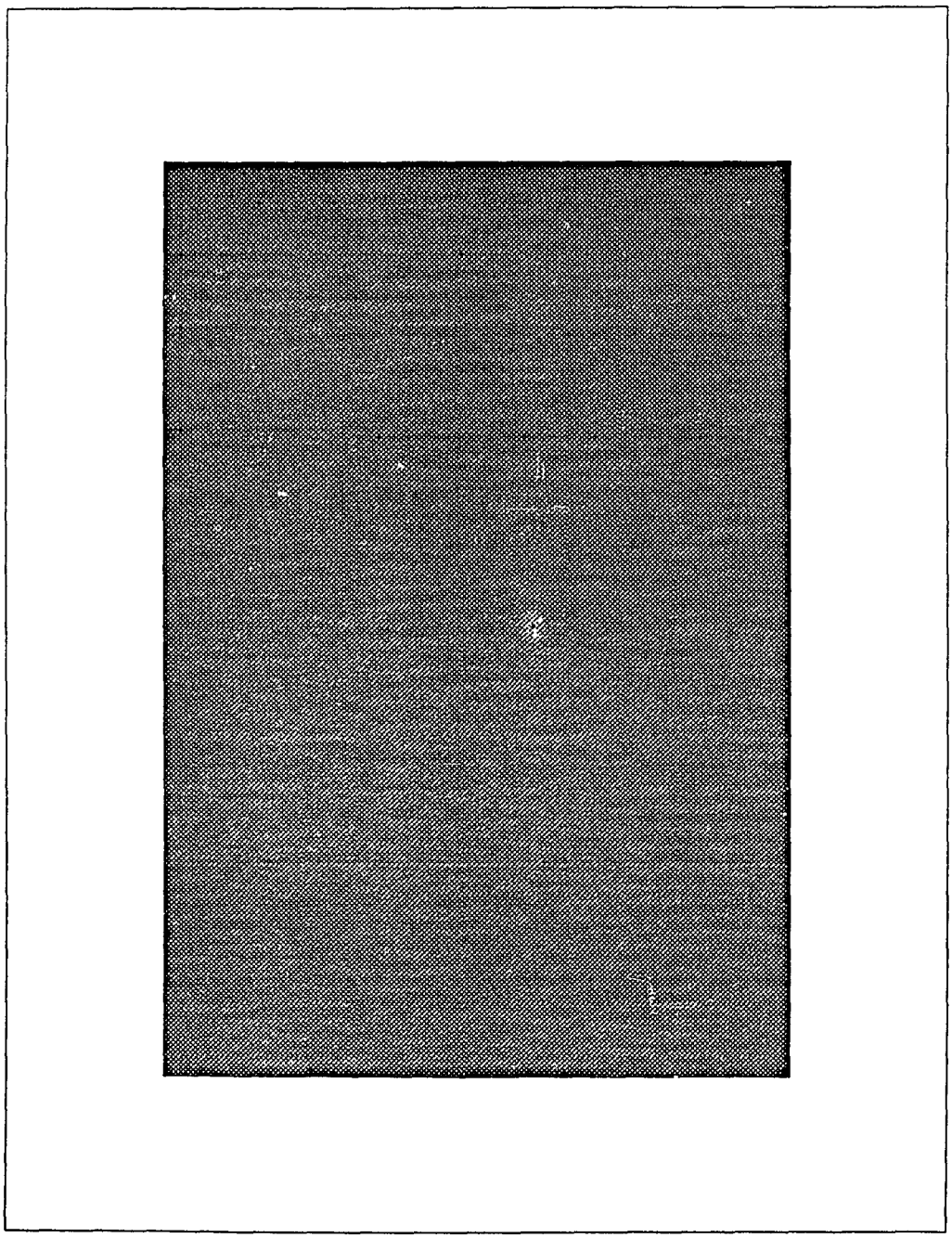
there	drive	start
water	fight	above
bench	given	early
types	often	later
words	house	broke

All capitals:

THERE	DRIVE	START
WATER	FIGHT	ABOVE
BENCH	GIVEN	EARLY
TYPES	OFTEN	LATER
WORDS	HOUSE	BROKE

Word form aids legibility

Paterson, D. G. & Tinker, M. A. (1938). The part-whole proportion illusion in printing. Journal of Applied Psychology, 22, 421-425.



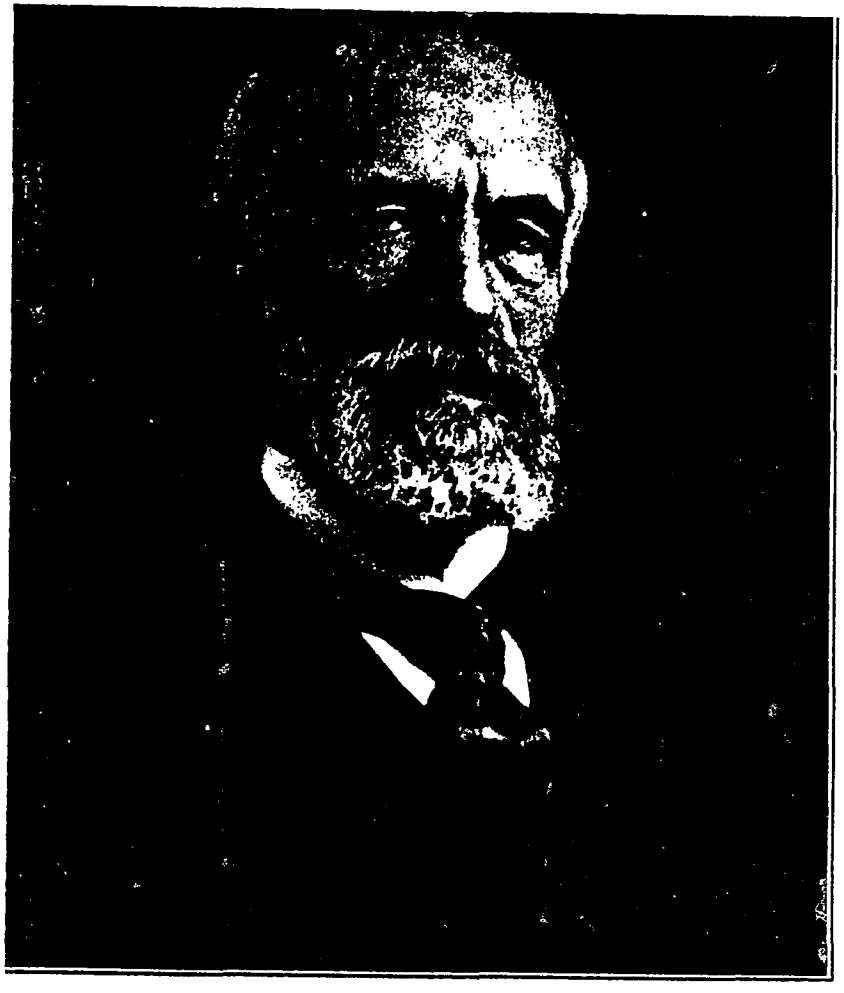
Print which covers 50 % of the page appears to cover 75 %

Appendix E:
Photographs -- Tinker and his Contemporaries

WILHELM WUNDT

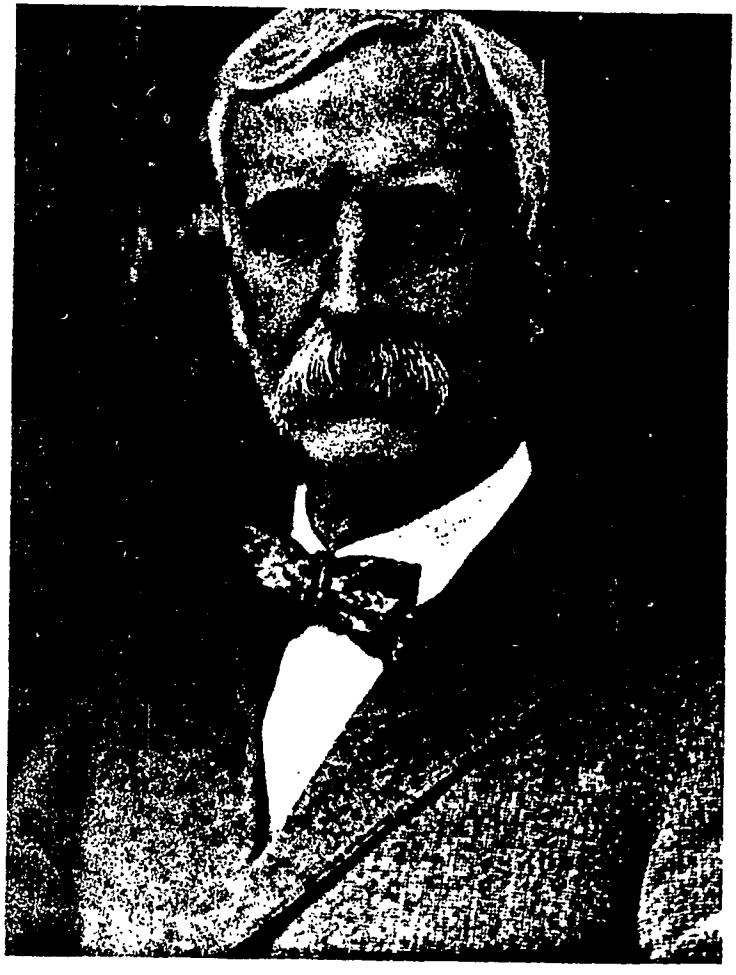
BORN AUGUST 16, 1832

Wilhelm Wundt, Leipzig, Germany.
The father of American psychology.
Tinker family files.



GRANVILLE STANLEY HALL
President of the University, 1888–1920

Granville Stanley Hall, President, Clark University.
Trained by Wilhelm Wundt in Leipzig, Germany.
Tinker family files.



Edmund Clark Sanford
1859-1924

Edmund Clark Sanford, Tinker's mentor at Clark University, trained by G. Stanley Hall at Harvard University.
Tinker family files.

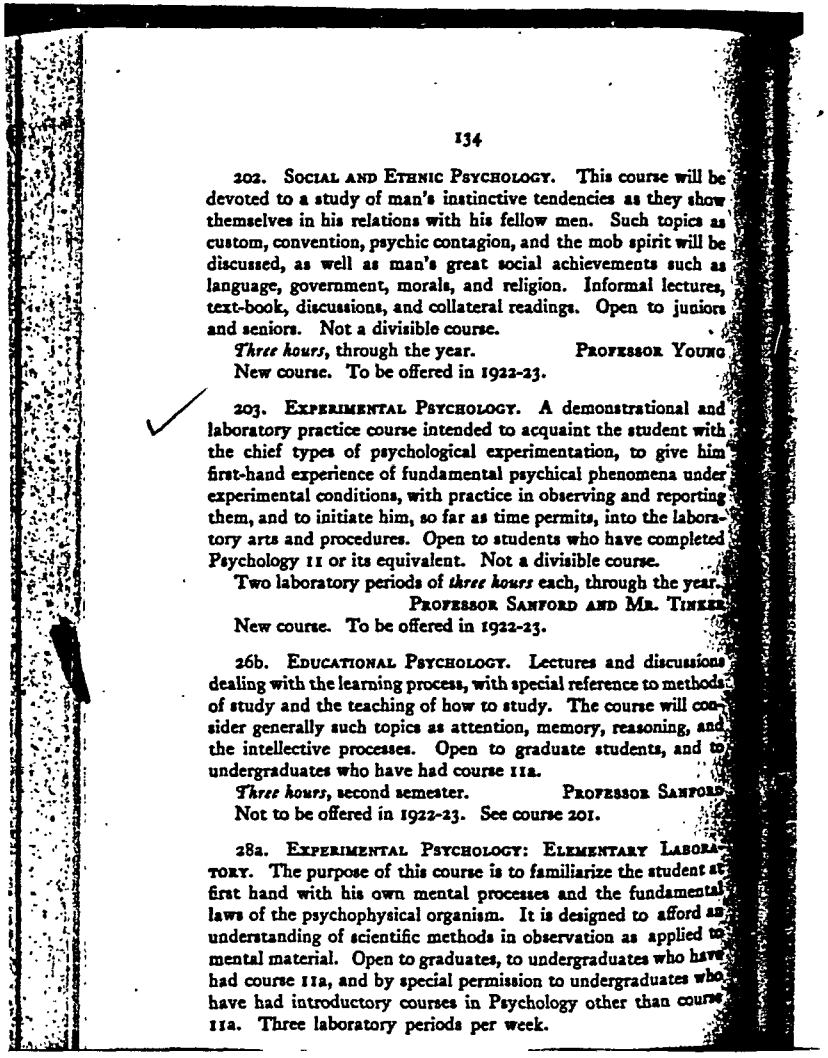
MILES ALBERT TINKER

Δ M A E Y

Born in Huntington, Mass.
Prepared at Westfield High School.
1918-19 Student at Ohio Northern University, 1917-18. Enlisted United States Naval Reserve Force, June 4, 1918; discharged, Dec. 10th, 1918.
1919-20 Elected Scholarship Society; First Honors.
1920-21 Chairman Election Committee; Biography Committee; Invitations Committee; Sub-Freshman Committee; Vice President Senior Class; Manager of Book Store; Assistant in Psychology; Treasurer of Scholarship Society.

Although a son of patriot soil, Tinker came to us in 1919 from the Middle West. Transferring from Ohio Northern University to Clark, Tink started "right" from the very first and has kept the faith ever since. Although he is ordinarily conservative and has learned from the Bible that "Silence is golden," he will converse quite freely and engagingly when in the mood. His quiet statement about anything may be taken on faith as gospel truth. A ten million neurone brain, and a faculty for understanding and "siking" all situations will lead him through any difficulties he may meet in the future.

The whole class knows that he is a man's man and an earnest student. His record forecasts a straight-away for a successful career. His particular friends know him as a hard worker, who goes after each task as though life depended on it, and makes each accomplishment a mark for others to reach. In his relations to us he has been as one who knows and understands us through and through, yet likes us just the same. Tinker is a gentleman and a scholar.



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202. Social and Ethnic Psychology. This course will be devoted to a study of man's instinctive tendencies as they show themselves in his relations with his fellow men. Such topics as custom, convention, psychic contagion, and the mob spirit will be discussed, as well as man's great social achievements such as language, government, morals, and religion. Informal lectures, text-book, discussions, and collateral readings. Open to juniors and seniors. Not a divisible course.

Three hours, through the year. Professor Young

New course. To be offered in 1922-23.

203. Experimental Psychology. A demonstrational and laboratory practice course intended to acquaint the student with the chief types of psychological experimentation, to give him first-hand experience of fundamental psychical phenomena under experimental conditions, with practice in observing and reporting them, and to initiate him, so far as time permits, into the laboratory arts and procedures. Open to students who have completed Psychology 11 or its equivalent. Not a divisible course.

Two laboratory periods of *three hours* each, through the year. Professor Sanford and Mr. Tinker

New course. To be offered in 1922-23.

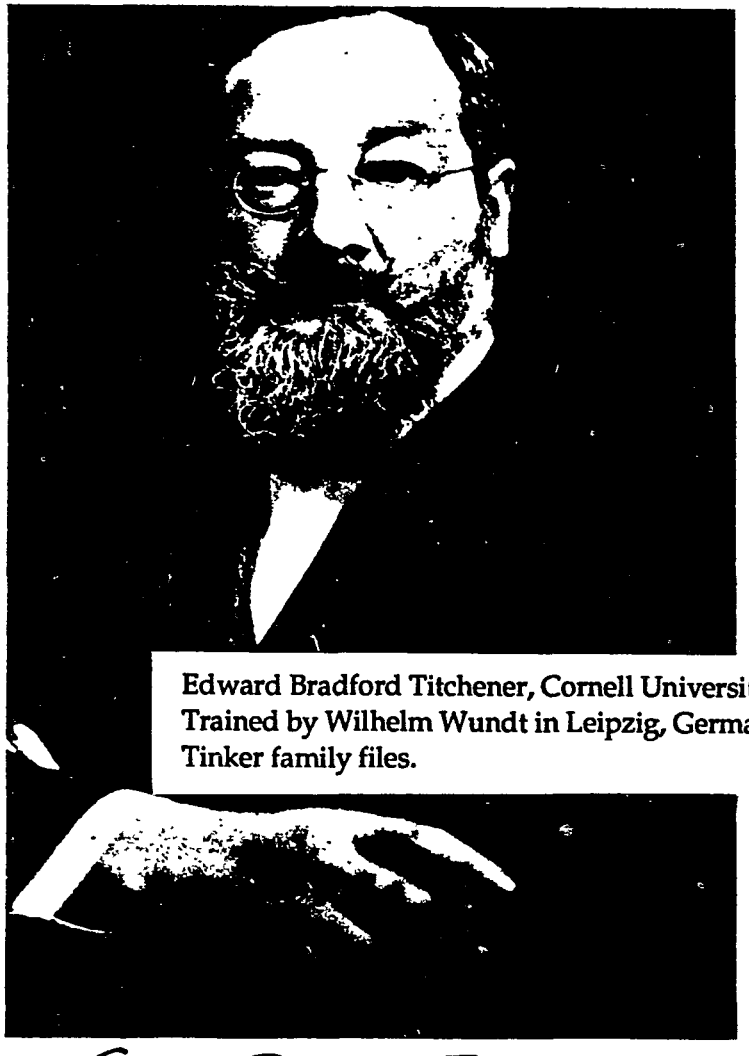
26b. Educational Psychology. Lectures and discussions dealing with the learning process, with special reference to methods of study and the teaching of how to study. The course will consider generally such topics as attention, memory, reasoning, and the intellective processes. Open to graduate students, and to undergraduates who have had course 11a.

Three hours, second semester. Professor Sanford

Not to be offered in 1922-23. See course 201.

28a. Experimental Psychology: Elementary Laboratory. The purpose of this course is to familiarize the student at first hand with his own mental processes and the fundamental laws of the psychophysical organism. It is designed to afford an understanding of scientific methods in observation as applied to mental material. Open to graduates, to undergraduates who have had course 11a, and by special permission to undergraduates who have had introductory courses in Psychology other than course 11a. Three laboratory periods per week.

Clark University catalog, 1921-22.
Tinker's first Psychology teaching assistantship
Courtesy of Clark University.



Edward Bradford Titchener, Cornell University.
Trained by Wilhelm Wundt in Leipzig, Germany.
Tinker family files.

Edwin Garrigues Boring, another Tinker mentor at
Clark University. Trained by E. B. Titchener.
Tinker family files.

Lewis Madson Terman, Stanford University, circa 1940
Trained at Clark University with Hall and Sanford.
Tinker family files.

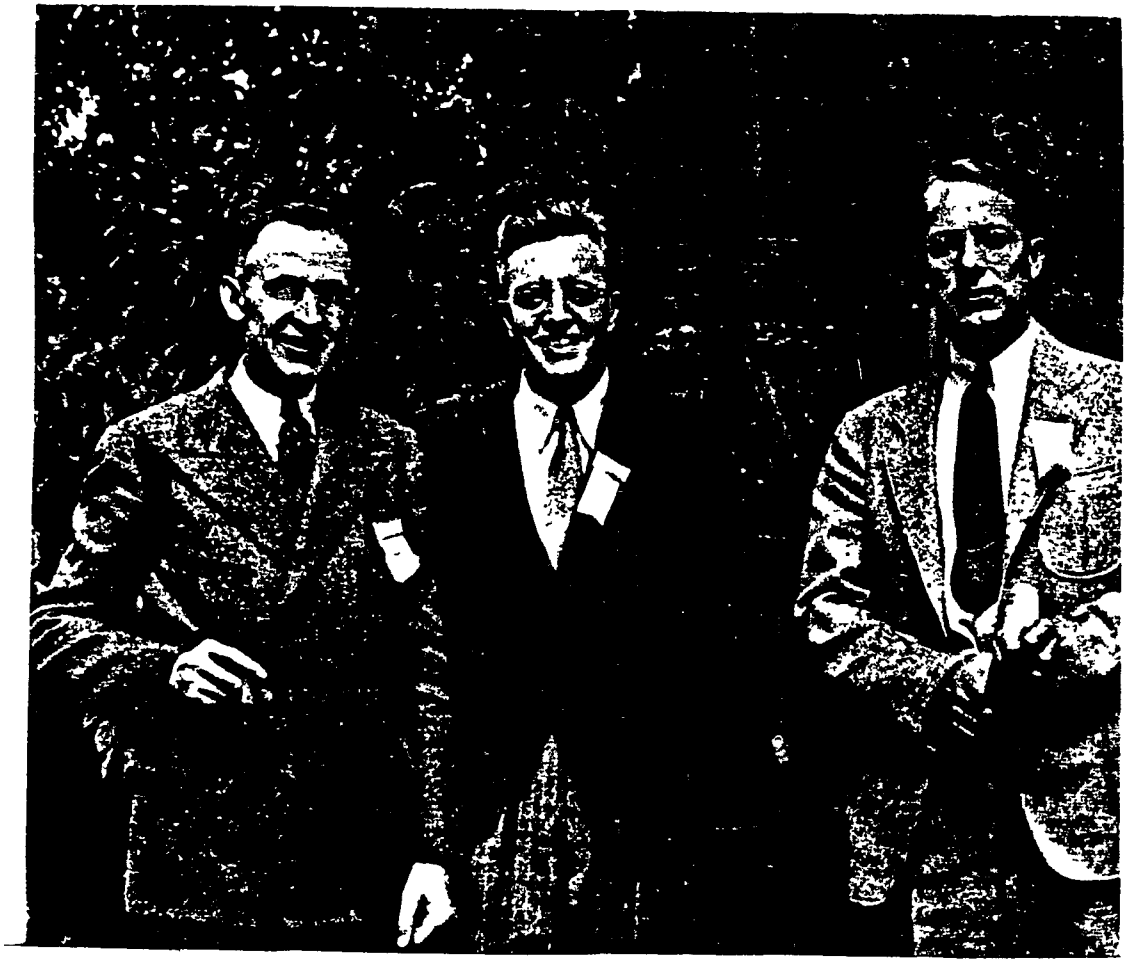
Walter R. Miles, Tinker's mentor at Stanford University.
Trained at University of Iowa, left Stanford soon
after Tinker graduated for a career at Yale University. 1931.

Donald G. Paterson, soon after arriving at the
University of Minnesota, early 1920s.
Trained by Rudolf Pintner at Ohio State University.
Courtesy of Walter Library Archives, University of Minnesota.
(also in Tinker family files)

Miles Albert Tinker, soon after arriving at the
University of Minnesota, circa 1930.
Trained by Sanford, Boring, Terman, & Miles.
Courtesy of Walter Library Archives, University of Minnesota.

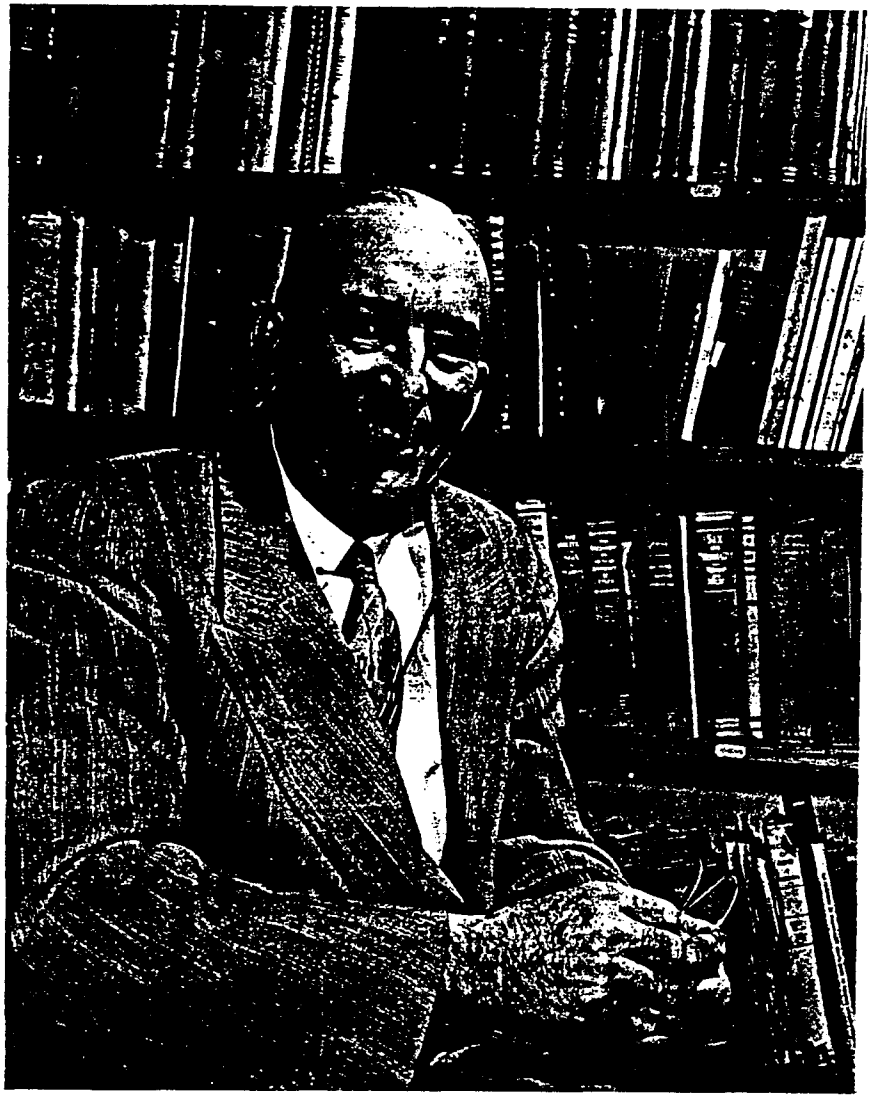
Donald G. Paterson, 1930s.
Tinker family files.

Donald G. Paterson, 1940s.
Tinker family files.



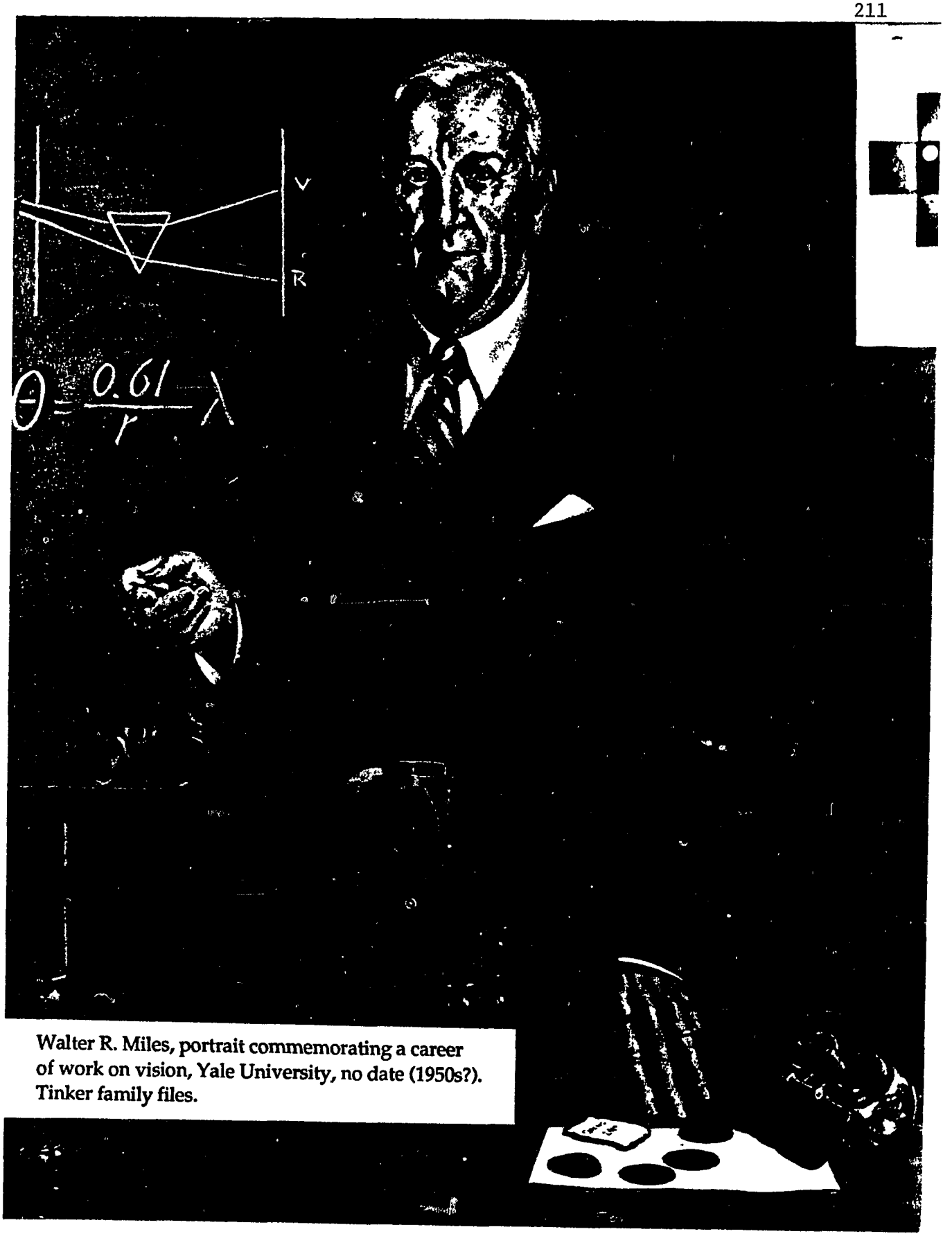
Miles A. Tinker, Paul Farnsworth and "Bevereuter" (?)
Circa 1940s, Tinker family files.

Miles A. Tinker in his retirement years, 1960s.
Tinker family files.



Donald G. Paterson, 1953.
Walter Library Archives, University of Minnesota.

Donald G. Paterson, circa 1960.
Walter Library Archives, University of Minnesota.



Walter R. Miles, portrait commemorating a career of work on vision, Yale University, no date (1950s?). Tinker family files.

Richard M. Elliott, portrait hanging in lobby of Elliott Hall, University of Minnesota.
Tinker family files.

Dedication of

ELLIOTT HALL

September 20, 1968

NAMED IN HONOR OF
RICHARD MAURICE ELLIOTT
PROFESSOR AND CHAIRMAN
DEPARTMENT OF PSYCHOLOGY

1919 - - 1951

AND

PROFESSOR

1951 - - 1956

DEDICATED SEPTEMBER 20, 1968

Richard M. Elliott
Trained by Hugo Munsterberg (trained by Wundt) at Harvard University.
Commemorative brochure at dedication of Elliott Hall, 1968.
Tinker family files.

Appendix F:
Dissertation Production Notes

Dissertation Production

This document was produced according to two sets of guidelines. The first and primary source was the research of Miles A. Tinker as set forth in this work. Tinker's guidelines were then adapted to those in the Style and Policy Manual for Theses and Dissertations (1988) of the University of Washington Graduate School.

Page layout is a compromise between margins demanded by UW and parameters of ZOT. Type size is predominently 10 point, as per Tinker's recommendations. Leading is 15 point, equivalent to 1-1/2 spacing according to UW guidelines. Line length is 23-26 picas, somewhat longer than Tinker's optimal, but still within ZOT. Type style was carefully considered. Palatino was chosen as the reading type face, while Bookman was chosen for headings. All of these choices follow ZOT requirements as closely as possible. As a scholarly work designed for transfer of information visual design was intentionally conservative.

This dissertation was produced with state-of-the-art technology. It was begun on a 1983 Kaypro 4 computer (in 1987) using Wordstar word processing software. In November of 1988 it was transferred via telephone modem from the original equipment to a Macintosh II computer into Microsoft Word software. Most final-stage production was completed with Aldus Pagemaker software on a Macintosh SE equipped with a Jasmine.Direct Drive 45 (external hard drive). Graphs were produced with MacDraw software. Finally, this dissertation was printed on an Apple Laserwriter II NT.

Photographs were copied from originals in the Tinker family files and the University of Minnesota Archives on a Kodak copier. Then they were laid out with captions and re-copied, again on a Kodak copier.

Presently some of Pagemaker's features are cumbersome, but powerful in comparison with others available. Programs such as Microsoft Word are gaining features as programs like Pagemaker gain range and flexibility. Likely programs will soon be convenient in simple word processing mode as well as offering powerful features which allow more latitude in the design process. It is predicted that within three (perhaps two) years the equipment named above will be obsolete.

Vita Update

The following activities have occurred since the preparation of the C. V. which follows:

Employment:

1988-pres.: Assistant Professor, University of Oklahoma, Department of Educational Psychology, area of Educational Technology.

Presentations:

October 21, 1988 — International Visual Literacy Association, Blacksburg, VA. "The Forgotten Research of Miles Albert Tinker."

February 2, 1989 — Association for Educational Communication and Technology, "Tinker and Paterson's Thirteen Studies: Implications for Desktop Publishing and Computer Screen Design."

Publications:

Winn, W. D. & Sutherland, S. W. (1989). Factors influencing the recall of elements in maps and diagrams and the strategies used to encode them. Journal of Educational Psychology, 81 (1).

CURRICULUM VITAE

Sandra Wright Sutherland

EDUCATION:

1985-pres. **University of Washington**, Seattle, WA
Ph. D. Curriculum and Instruction,
specialization in **Educational Communication and Technology**
Advisor: William Winn.
Cognates: Educational Psychology; Policy, Governance and Administration (history).
Out of college specialization: Graphic Design.
Emphases: research and theory, instructional design, interactive technologies, message design (print and computer screens), history, reading.
Dissertation topic: *The Forgotten Research of Miles A. Tinker, 1926-1977*

1970-1973 **San Diego State University**, San Diego, CA
M. A., Speech Pathology and Audiology, specialization in Education of the Deaf.
Federal Fellowship.
Thesis: *The Viewpoints of Thirty-three Deaf Individuals on Education of the Deaf*
1980, Summer: Classes in Educational Technology: intoduction to instructional design, computers in education, basic media production.

1966-1969 **University of Michigan**, Ann Arbor, MI
B. F. A., specialization in **drawing and painting.** Minor: Social Science
College of Architecture and Design. **Senior Class Honors.**

1965-1966 **Wayne State University**, Detroit, MI School of Art.

OTHERS:

1973-1984	**Palomar College**, San Marcos, CA. Variety of classes to strengthen skills for tutoring deaf and hard of hearing students in regular class high school subjects. Sabbatical year: graphic arts and photography study.
	Also attended: U. C. San Diego; U. C. Santa Cruz; U. C. Berkeley; Cabrillo College, University of Wisconsin, Green Bay; non-degree objectives.
1964-1965	London (Ontario) schools, Canada
1962-1964	Point Loma High School, San Diego, CA (graduated, 1965)
1959-1962	Karlsruhe American Schools, Karlsruhe, Germany
1958-1959	Orleans Elementary School, Orleans, France
1952-1958	Whittier Elementary Schools, Whittier, CA

CREDENTIALS:

California Community College Instructor; Special Education, Art.
California Standard; Art, Deaf and Hard of Hearing, K-12, Life.
Michigan Permanent; Art, Deaf and Hard of Hearing, K-12, Life.

AWARDS AND HONORS:

1986-1988	**Teaching Assistantship**, University of Washington, Seattle, WA
1987-	**Pi Lambda Theta**, National Honor Society and Professional Association in Education, membership.
1984	**Two firsts, one second place**, Graphic Arts, Southern California Exposition at Del Mar, CA
1970-1971	**Federal Fellowship**, San Diego Sate University, San Diego, CA
1976	**Listed:** ***Who's Who*** of American Women, International Who's Who of Women, Dictionary of International Biography, Notable Americans
1969	**Senior class honors**, University of Michigan, Ann Arbor, MI

PUBLICATIONS:

1987 **Graphic illustration,** Charts, Graphs, and Diagrams in Educational Materials *by William Winn,* Ch. 5, in *The Psychology of Illustration,* D. Willows & R. Houghton, (eds.). Pgs. 156, 162, 164, 182.

1986-1988 **Sutherland, S. W. & Winn, W. D.** (1987, February). *The effect of the number and nature of features and of general ability on the simultaneous and successive processing of maps.* Paper presented at the annal convention of the **Association for Educational Communication and Technology,** Atlanta, GA (also in the proceedings)

Sutherland, S. W. (1987, October). *Wayfinding in computerized card catalogs: Library of Congress vs. Gallaudet University.* Paper presented at the annual meeting of the International Visual Literacy Association, Tulsa, OK (also in the proceedings)

In preparation: **Winn, W. D. & Sutherland, S. W.** (1988). *Factors influencing the recall of analytically- and holistically-processed information presented in maps and diagrams.*

Sutherland, S. W. (1988). *Design of computer screens: Recommendations from a multi-disciplinary perspective.*

Sutherland, S. W. (1988). *Problems in electronic card catalogs: A case study.*

Sutherland, S. W. (1988). *Tinker and Paterson's thirteen studies of typographical factors influencing speed of reading: Forgotten research.*

Non-academic audience: **Sutherland, S. W.** (1979). *The top toad.* Instride, 2 (2), 24-27. (including photos).

TEACHING:

1986-1988 **University of Washington,** Predoctoral Teaching Associate, under direction of William Winn and Stephen Kerr. **Taught:** Still Photography in Education, 4 quarters. **Assisted:** Interactive Video, (WICAT WISE, Pilot, Propi); Computer Graphics; Instructional Design, research. **Used:** IBM, Mac, Tandy, Apple, Cyber; Wordstar, Word, Pagemaker, SPSS+, assorted educational software.

Teaching (cont.)

1972-1985 **Escondido Union High School District,** Escondido, CA. Teacher, Coordinator, Program for the Hearing Impaired. Itinerent program, grades 9-12. **Supervised** integration of students into mainstream academic and vocational programs; **Interviewed, supervised** and **scheduled** notetakers and interpreters; **Tutored** all subjects normally taught in high school. **Team-taught** graphic arts (printing) in coordination with regular class teachers, and Computers in Special Education. **Administered** budget, ordered equipment and supplies; **Advised** students in academic and vocational pursuits; **Scheduled** classes, interpreters, vocational activities. **Organized** local college visitations, outside speakers (recruiters, Department of Rehabilitation, etc.). **Wrote** district guidelines for: 1) Job description; 2) Stull Bill evaluation; 3) WASC evalutation, DHH program; 4) EUHSD district goals and objectives, DHH program. **Advisor:** Sign Language Club. **Computers:** TRS-80, Commodore Pet and 64, Apple II, Kaypro. In-service training: IBM PC jr.

1976-1977 **Palomar College,** San Marcos, CA Lipreading specialist, Handicapped Services.

1976-1977 **MiraCosta College,** Oceanside, CA Lipreading instructor, Continuing Education.

Summers:

1978 **Carlsbad Unified School District,** Carlsbad, CA. Kindergarten teacher, Deaf and Hard of Hearing, Magnolia Elementary School.

1973 & 1974 **San Diego City Schools,** San Diego, CA. Teacher, grades 4, 5 & 6, Deaf and Hard of Hearing, Lafayette Elementary School.

1973-1974 **Escondido Adult School,** Escondido, CA Lipreading teacher.

1972-1973 **Poway Adult School,** Poway, CA Lipreading teacher.

1972, Spring **San Diego City Schools,** student teacher, junior high school and pre-school levels, DHH.

1969-1970 **San Diego City Schools,** substitute teacher, secondary (7-12), regular classes.

Media Production:

1987 **Graphic illustration,** Charts, Graphs, and Diagrams in Educational Materials *by William Winn,* Ch. 5, in *The Psychology of Illustration,* D. Willows & R. Houghton, (eds.). Pgs. 156, 162, 164, 182.

1985 **Photography,** *Olympic Nightmare* (starting line loss of the Olympic Gold Medal, 1984 Team Pursuit bicycle race). Accepted and exhibited, Southern California Exposition at Del Mar, CA. Also printed in Winning Magazine, Coast Dispatch Newspaper.

1983-1984 **Book,** *Bicycle Training for the Triathlete *and Others* by Audrey McElmury and Michael Levonas. **Photography and graphic design** by Sandra W. Sutherland. **Published,** single-handed: typesetting (computerized), layout, paste-up, line and half-tone film work, stripping, burning of plates, printing, collation, bindery and marketing. **Sold** over 2,000 copies.

1984, August **Photo-essay,** *Sue Krenn, 1950-1984*, San Diego Track Club Newsletter. All photos, one of four articles.

1982 **Photo-essay,** *Tecate-Ensenada Bicycle Race*, exhibited, Laffen's Bicycle Shop, San Diego, CA

1978-1982 **One person exhibits,** photography, Phidippides and Movin' Shoes stores, America's Finest City Half-Marathon pre-race dinner, San Diego, CA

1979 **Staff writer,** Instride Magazine, Mission Viejo, CA

1977 **Writer, photographer,** Fourth Estate newspaper, University of Wisconsin, Green Bay, WI

ACADEMIC EXPERIENCE:

Scholarship:

1988 **Research Project,** University of Washington, Sandra Sutherland and William Winn. The Effects of Placement on Processing of Elements in Diagrams. Developed test materials for project, completed arrangements for on-site testing and human subjects review, teacher preparation, collected data, coordinated scoring, co-authored report.

1987 **Research Project,** University of Washington, William Winn. *Simultaneous and Successive Processing of Maps and Diagrams.* Developed test materials based on past line of inquiry, participated in school-based collection and analysis of data, co-author of report.

1986 **Research Project,** University of Washington, William Winn. *Simultaneous and Successive Processing of Maps.* On-campus collection and analysis of data for on-going line of inquiry, co-author of report, presentations.

Service:

University of Washington

1987-1988 **Budget Committee**, Student representative, College of Education, University of Washington.

1985-1988 **Doctoral Student Support Group**, member.

1987-1988 **Association for Educational Communication and Technology**, (AECT) interpreter for deaf attendees from Gallaudet University at annual conferences, Atlanta (1987) and New Orleans (1988).

1987 **University Hospital**, interpreter for deaf suicidal patient.

Escondido Union High School District

1982-1983 **Sign Language Club**, Advisor, Orange Glen High School

1975-1976 **California Association of Teachers of the Hearing Impaired** (CATHI), Membership Chair

1972-1974 **Sign Language Club**, Advisor, Orange Glen High School

1973 **North County Parents, Teachers and Friends of the Deaf**; organized, established, member.

PROFESSIONAL ASSOCIATIONS:

1988- National Society for Performance and Instruction (NSPI)

1987- International Visual Literacy Association (IVLA)

1987- **Pi Lambda Theta**, National Honor and Professional Association in Education, Zeta Chapter

1986- American Educational Research Association (AERA)

1986- Association for Educational Communication and Technology (AECT)