TEMPORAL PERCEPTION OF GOOD AND POOR READERS

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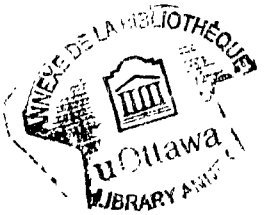

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CURRICULUM STUDIORUM

The writer was born on December 5, 1927, in New York and moved to Los Angeles, California in 1931. He received a Bachelor of Arts with a major in Psychology from the University of California at Los Angeles in 1950, and a Master's Degree from the same University in 1956. Thesis: School Achievement of Mentally Retarded Children in Special and Regular Classes.

TABLE OF CONTENTS

LIST OF TABLES

INTRODUCTION

Interest in the improvement of reading is universal today. Clinical psychologists and psychiatrists are becoming increasingly interested in the problem of reading defects because a noticeable proportion of poor readers develop emotional tensions and conflicts. School systems, court clinics, institutions for delinquents and other agencies have long been aware of the importance of reading to an effective general adjustment. The incidence of emotional disturbance among children with reading disability cases is impressive; evidence shows that the more serious the reading retardation, the greater is the possibility that maladjustment also exists.

Any type of deficiency tends to create a feeling of inferiority and inadequacy. In this pattern the person tends, at first, to rationalize his deficiency in terms of reducing the importance of the problem, or in terms of some unavoidable cause which may indicate that he is not at fault.

The poor reader, however, usually has much more difficulty in rationalizing because every phase of his academic career and his other adjustments is directly or indirectly affected by his defective reading ability. Psychiatrists have observed that to a significant frequency a great sense of frustration and failure accompanies reading difficulty. This is partly due to the fact that everyone is expected to be able to read adequately in order to advance

in his schooling. Reading is also considered a criterion, in the cultural sense, of an individual's mental ability.

In the United States, estimates range from five to forty percent of pupils in various schools who are retarded readers. This number is sufficiently large to cause genuine concern. Since the 1920's, reading clinics have mushroomed throughout the country. The major functions of these clinics have been to study types of reading disabilities and to design procedures that would give control over the reading process to children who are retarded in reading.

Frequently retardation in reading is confused with general mental retardation. While reading retardation has been found on all levels of intelligence, some investigators have revealed that as many as 80% of the retarded readers possess average or above-average intelligence. One of the major problems faced today in this field is to secure general agreement as to the meaning of terms adopted by specialists and teachers.

The literature reveals considerable disagreement concerning terms regarding the learner who is reading below his estimated potentiality. He may be designated as a poor reader, a retarded reader, a disabled reader, a case of alexia, or dyslexia, or of strephosymolia. Certain specialists in the field might choose one or another of these designations as being more nearly in harmony with their theories

of reading disability than the others. Even though the same designation is applied, there are varying standards by which pupils are classified in various groups. For example, a pupil may be considered a retarded reader in one school if he attains reading achievement scores six months below his measured mental age, while in another school he is not so classified unless the retardation is one or two years. All these differences make it essential that each person describe or define his concept of terms used.

For the purpose of this study, a retarded reader should be regarded as the individual whose reading achievement falls significantly below his capacity for reading. Capacity for reading in its broadest connotation, as used here, includes the pupil's physical, emotional and social development, as well as his mental maturity.

In the light of current knowledge of child development, reading achievement is thought to be one aspect of the total growth of an individual. For this reason, expectancy of achievement in reading appears to be dependent upon a number of factors including intelligence, emotional well-being, and physical development.

Reading, however, begins with perception. In spite of its subjectivity, we cannot deny perception as being the key to the individual's action. It provides him with the immediate as well as the ultimate foundation of experience.

In many ways perception is analogous to a lathe that makes the tools responsible for the functioning of the individual. In this way, the relationship between the perceptual process and reading ability becomes more vivid. Basically, reading is one medium through which man receives communication, and by which he is able to understand his past and construct his future. However, the ability to read, to comprehend, and to integrate is directly determined by, and dependent on, the perceptual processes.

Reading is a highly complex performance in which vision, eye movements, inner speech, memory, word-knowledge, inferences, past experience, and general intelligence all combine to produce the effects observed. It is not possible to describe the whole process as an entity; one must start with some one phase of the total problem.

The present study is a result of the writer's increasing interest in the total perceptual process, and, his desire to investigate the relationship of one aspect of this process, namely, temporal perception, with reading ability. Though it is universally agreed that perception plays a major role in the reading process, the temporal factor of perception has not as readily been established as a distinguishing criterion between good and poor readers.

The present work intends to investigate, experimentally, the temporal aspects of perception as it is

related to reading. Before doing so, however, it is necessary to present the concept of temporal perception, and then to explore the literature and relate the pertinent findings of other workers who have investigated various problems relating to perception and the reading process.

CHAPTER I

TEMPORAL PERCEPTION

Since this study is primarily interested in the temporal element of perception and its relation to the reading process, this chapter will attempt to present an explanation of three prerequisites to the study. An understanding of temporal perception will be presented, followed by a brief outline showing the relationship between temporal perception and some major theories of perception. An explanation of these seems necessary since it will serve as a frame of reference for the time element which is but one aspect of the perceptual process. Lastly, this chapter will relate reading to the perceptual process and thereby directly focus on the temporal feature of perception in relation to reading.

1. Definition of Temporal Perception

As a starting point, the meaning of perception must first be defined so that the reader may have a basic tool for understanding what will follow. Perception is here defined as a physio-psychological integration of external stimuli into meaningful patterns. The term pattern as used by the writer is defined as the complex of elements and events making up an act of behavior. For a clearer understanding of these terms, it is necessary to deliberate further.

Within the process of perception, a number of sequential events must be considered. First, there is the object to be perceived. This usually lies at a distance from the perceiver, in the cases of vision and hearing, for example. Secondly, as in the case of vision, there is the intervening light waves or other conditions that form a pattern of energy change in the sense organ, at a receptor surface. Next, there is a flow of impulses conducted toward the brain along afferent neurons. These impulses go to lower brain centers and to sensory projection areas of the cortex. Some series of events now occur in the central nervous system, most likely in the cerebral cortex. Such a series includes synaptic connections and the involvement of other neurons in the area which extend to other association areas. To complete these steps there should be added the presence of organic states that might influence perceptual activity, as for example the influence of the autonomic system.

Whatever the mechanisms of interaction within neural fields may be, each new experienced integration -- perceptual pattern -- involves a process of reorganization that cannot be instantaneous: integration in time necessarily accompanies integration in space. Moreover, a small number of successive events, if not too far apart, can be perceived as a unified

configuration[1] of temporal Gestalt; if the intervals are too brief, discrimination even becomes impossible and often new perceptive modalities appear. Some structure in the brain, then, must constitute a "time-binding" mechanism.

Time and perceptual integration appear in intimate relationship in another way: that in which perceptual patterns succeed one another. This process is an unconscious one, and, according to Lashley, "We are still very far from being able to form an explicit explanation of temporal structure."[2] With regard to our discussion, this process helps us to realize how we can be mistaken when in a retrospective judgment we try to appreciate the richness of content and power of action of any definite perceptual experience. Our judgment is itself the result of the temporal integration of successive experiences and of these with older memories.

Thus we have one physiological explanation of why things appear to the individual as they do. From this explanation we can also in part answer the question: Why is there a difference in <u>time</u> of perception among individuals? Bender[3], in her report of tachistoscopic phenomena relating to certain

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1 Illustrated by Wertheimer's <u>Phi-phenomenon</u>.

2 K. S. Lashley, <u>Cerebral Mechanisms in Behavior</u>, New York, Wiley and Sons, 1951, p. 112-146.

3 Lauretta Bender, "A Visual Motor Gestalt Test and Its Clinical Use," <u>Research Monographs</u>, No. 3, New York, The American Orthopsychiatric Association, 1938, p. 47-54.

laws of gestalt, experimentally established the existence of a temporal factor in perception and indirectly contributes to answering the above question:

> The first principle of perception is the motility that is present usually in whirls of the visual field, which, in itself, assumes time; the second principle is direction, usually horizontal and dextrad, which assumes time; the third is mass which is two dimensional direction, and which assumes time. Actual forms arise from these by inhibition of the movement of whirling into closed circles or segments of circles; of the direction into a line; and of the mass into form on a background. Inhibition means taking a unit of time. The complexity of the pattern experienced depends on the capacity for immediate perception of different units in accordance with the principles laid down by the perceptual and motor patterns.

2. Time Factor in Perceptual Theories

An investigation into some of the major theories of perception reveals the existence of a common denominator, namely, a time element.

The gestalt theory[4,5] is one of the basically consistent theories of perception. Though it has been criticized on the basis of its brain-field theory, and its treatment of wholes and parts, nevertheless it solidly rests upon

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4 Wolfgang Köhler, Gestalt Psychology, New York, Liveright, 1929, ix-720 p.

5 Kurt Koffka, Principles of Gestalt Psychology, New York, Harcourt, 1935, vii-403 p.

a large number of experiments which serve to support its generalizations. In the gestalt theory of perception, a time element is markedly prominent. The gestalt theory agrees that the percept does not depend on the pattern of points in the peripheral stimulation and consequently a point-to-point projection to the cortex, but rather it depends upon what happens in the macroscopic electric fields of the cortex after the afferent impulses are received at cortical projection areas. The "timing" within the perceptual process can logically be effected if it can be considered as one of the aspects involved in the cortical phenomenon. That is to say, that when a current has been passing through a medium for some time its effects alter that medium. To elucidate, chemical deposits may accumulate on the interfaces of cells; and polarization of membranes may occur that will alter or oppose the current's further passage in the same direction. There then we can consider a change in the timing operation within the process.

Another theory of perception based on physiological constructs is the cell-assembly theory[6]. This theory is built directly upon certain facts of neurophysiology, genetic development, and brain pathology. For the gestalt theory, the aggregates of perception are contours, surfaces,

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6 Floyd Allport, Theories of Perception and the Concept of Structure, New York, Wiley, 1955, p. 164-182.

segregated figures, and figures differentiated from grounds. For the cell-assembly theory, the aggregate consists of perceived lines and angles that give a figure its individualized character. Physiologically, there are motor elements in the form of eye movements, cell-assemblies of pathways in the cortex and end-knobs at synapses. Efferent neurons and muscular contractions are also part of the aggregate. The perceptual aggregate and operation is accomplished by growth of the end-knob connections between neurons through use. This type of interfacilitation, combined with timing of neural impulses, result in the final perceptual aggregate.

The cell-assembly theory follows the associative doctrine of perception, but contrary to Gestalt configurationism, explains the perceptual aggregate by the joining of specific elements, one-to-one, into neurophysiological combinations. Although the two theories are opposed to each other in so far as how the perceptual aggregate is formed, nevertheless, they are in complete agreement on two important points — first, what elements make up the aggregate, that is neurological cells, and secondly, that the aggregate involves a timing operation within its process.

Still another theory involving the dimension of time is the hypothesis theory of Bruner and Postman[7]. This theory is based upon the hypothesis that dynamic factors such as needs, values, and personality characteristics of the individual have much to do with the way the world appears to him. Three basic steps are involved in this theory of perception. First, the individual is a "tuned" organism, constantly prepared for sensing, in the broadest terms, some particular thing. Thus, he is always in a state of expectancy or hypothesis. The hypothesis results from the arousal of central cognitive and motivational processes by preceding environmental states of affairs. The second step in the perceiving process is the input of information from the environment. Here the term information refers to the stimulus input. The third step in the cycle is checking or confirming procedure. The stimulus input, or "information," is either confirmatory to the operative hypothesis, or it is incongruous or infirmatory with the hypothesis.

Closer scrutiny of this theory shows that the perceptual aggregate involves autonomic factors, in the expression of emotions, and contains exteroceptive sensory and

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7 Bruner and Postman's term "hypothesis" refers to the cognitive processes, whether they take the form of perceiving, thinking, or recalling, which the organism sets up, or that are evoked by the particular situation.

cortical components. In regard to how the hypothesis-theory explains the make-up or "workings" of the aggregate, it is found that there is no stipulated mechanism other than its general reference to set. Where the gestalt theory explains the aggregate by way of sensory stimulation setting up brain field of electric currents, the hypothesis theory uses such terms as trial and check, stimulus-information and transformation, and selection. In terms of meaning related to the aggregate, the hypothesis theorists consider meaning to be in the hypothesis and in the checking against stimulus information by which the hypothesis is tested. In terms of recognition-threshold, according to the theory of Bruner and Postman, hypothesis-strength is measurable by the amount of stimulus-input needed for confirmation or rejection. The stimulus exposures that are required are, in terms of behavior-theory, measures of reaction-potential via "latency."[8] The statement just mentioned is one aspect of the theory that is of particular importance in this research. It focuses attention on the significance of the time element in the theory. That is to say, the forming or arousing of hypotheses

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8 "Latency" here refers to a measurement of the time elapsing between the presentation of the stimulus and the occurrence of the response; and it is represented in perceptual experiments by the length of the period of exposure of the stimulus that is required for its perception. Latency can, therefore, be regarded as the duration-threshold of a perception.

in a situation, together with the receiving of information related to them, and the whole procedure of "trial and check" involves a threshold — the point at which the percept suddenly appears — and therefore involves the dimension of time.

The last theory to be mentioned is Hull's behavior theory[9]. This is an associationistic approach to perception and is worthy of attention here only because a temporal element is involved in the theory, and included in a way different from the three theories cited above.

Hull's theory is based on the linkage of a stimulus or stimulus-pattern to a reaction, and, the gradual strengthening of this connection. Learning involves the strengthening of this connection, the process being a manifestation of repetitions. More specifically, through the reduction of a need-state or drive (Hull's term is "reinforcement") which accompanies repetition of the stimulus, learning takes place. The well-known terms "habit-strength," "reaction-potential," and incentives and rewards are all factors in this theory. In terms of the perceptual aggregate, the behavior-theory makes little attempt to describe the formation and operation of the aggregate, though some regard is given in terms of goal responses, neural interaction, drive-components,

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9 C. L. Hull, A Behavior System: An Introduction to Behavior Theory Concerning the Individual Organism, New Haven, Yale University Press, 1952, xii-480 p.

associative spreading, and the intervening variables.

With the awareness that there are temporal spans within the perceptual pattern and that such time-durations could occur anywhere along the pattern sequence, an explanation of variations in temporal perception can be related to individual differences. These differences, measurable in terms of time, could be explained hypothetically as habit-strength, drive, reaction-potential, and reactive inhibition. In considering only the temporal aspect of perception, these "variables" are essential parts of Hull's behavior theory.

The time element of perception is a topic of considerable controversy. Though it is agreed that a very brief time-span is required for the perception of familiar objects, there is a wide difference of opinion as to whether perceiving is based originally on previous experience — as to whether at the <u>beginning</u> a perception is a learned habit, established with time and by repetitions.

The time element presented here refers to the duration threshold for object-recognition. It is a phenomenological consideration measuring the amount of time necessary for sufficient stimulus-energies to accumulate in the pattern to permit the object to be perceived.

3. Reading and Perception

So far in this chapter we have discussed temporal perception, and some theories in which the time element is an important factor. Since the ultimate aim of this chapter is to directly focus on the temporal feature of perception in relation to reading, a further consideration must be elaborated upon in addition to the ones above, namely that of reading and the perceptual process.

Probably the most illuminating contributions to an understanding of the nature of reading have come from those who have applied the science of psychology to various educational functions. The writer views the reading process essentially as a complex but unitary psychophysical function; a type of behavior or experience of an interactive character, in which reader and writer are in communication with each other and which produces changes in the reader, if he has at all responded to the meanings expressed by the writer. This implies a response of the whole personality, comprising ideational, emotional, attitudinal or motor aspects as they organize themselves to respond. Conceivably, it would be impossible to penetrate the meanings latent in the reading material without the appropriate equipment, for reading is a system of symbols which must be learned and which involves the mastery of part-processes in the evolving grasp of the whole system. The whole system refers to the personality of

the reader; the stimulating medium, in this case the symbolic system; and the processes set in motion between them, that is, the perceptual phenomenon. The part processes are usually referred to as the "skills." Interestingly enough, however, exercises designed to develop the skills of which reading is supposed to be composed do not as a rule achieve their intended purpose because reading is not composed of special skills. What mechanistic psychology regards as skills, are actually products of reading, not causes. They emerge already related in the reading process as a whole or they never develop. Reading, then, must not be broken up into specific techniques to be achieved at specific levels, but must be regarded as an evolving whole at all times. Here then perception and learning are involved. The whole perceptual aggregate and the complex learning process is integrally related with reading, since reading is a dynamic experience in which the human organism, involving physical, motor, intellectual and emotional systems, is at once operating.

The essential point of this chapter is that a time factor is present in the perceptual aggregate and that the temporal factor must be respected with regard to individual differences in perception; that is, temporal differences in the physio-psychological integration of external stimuli into patterns. Assuming that these perceptual distinctions hold for normal reading, the suggestion is that the reading

process on the perceptual side consists of a rhythmic alternation of stimulations and interpretations, each requiring a definite interval for its accomplishments.

Different workers have perceived the importance of the time element along with other essential factors determining the reading process. In order to give this study greater clarity and impetus, a review and evaluation of the literature will be presented in the following chapter.

CHAPTER II

REVIEW OF THE LITERATURE

Almost any investigation into individual reading problems should be considered from the point of view of the subject's development. In line with this thinking, it seems desirable to explore as many areas as possible pertinent to reading disability. In reviewing the literature numerous causal factors are mentioned by various investigators. Although it would not be practical to report on all these findings, nevertheless, the writer felt that among these many factors, four appeared to be most important in relation to reading ability, and therefore worth mentioning. Among the most relevant are intelligence, neurophysiological elements, emotional problems, and the one handled most sparsely in the literature, temporal perception.

Interestingly enough the subject of temporal perception has been investigated as early as 1879, when Javal, at the University of Paris, called attention to the fact that the passage of the eye across a line of print is discontinuous, consisting of eye movements and pauses. Since that time a great deal of research has been done in measuring eye movements, in determining the function of the fixational pause, and in relating these to both rate and

comprehension in reading. Investigators, such as Judd[1], Luckiesh[2], and Tinker[3], worked with the measuring of eye movements, usually with photographic equipment. Hinshelwood[4], Fendrick[5], Eames[6], Tinker[7], and Monroe[8], compared good and poor readers on the basis of visual maladjustments. A great deal of attention was given to perceptual span, comprehension,

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1 Charles H. Judd, "Photographic Records of Convergence and Divergence," Psychological Review, Monograph Supplements, No. 3, Vol. 8, issue of 1907, p. 370-423.

2 Matthew Luckiesh, Light, Vision, and Seeing, New York, Van Nostrand, 1944, xiv-323 p.

3 Miles A. Tinker, "The Role of Eye Movements in Diagnostic and Remedial Reading," School and Society, Vol. 39, (no number), issue of February 3, 1934, p. 147-148.

4 James Hinshelwood, Congenital Word-Blindness, London, Lewis, 1917, x-112 p.

5 Paul Fendrick, "Visual Characteristics of Poor Readers," Teachers College Contributions to Education, No. 656, issue of 1935, 54 p.

6 Thomas H. Eames, "Comparison of Eye Conditions Among 1,000 Reading Failures, 500 Ophthalmic Patients, and 150 Unselected Children," American Journal of Ophthalmology, Vol. 31, issue of 1948, p. 713-717.

7 Miles A. Tinker, "The Study of Eye Movements in Reading," Psychological Bulletin, Vol. 43, No. 2, issue of March, 1946, p. 93-120.

8 Marion Monroe, Children Who Cannot Read, Chicago, University of Chicago Press, 1932, 80 p.

and visual perception by Tinker[9], Luckiesh[10], Robinson[11], and Gates[12].

The majority of studies of eye movements and related subjects in regard to reading ability was done prior to 1948. After that period the literature seems to be more concerned with the remedial aspects of reading disabilities rather than with the etiology of it. Few investigators have attempted to relate reading disability as a result of the eye pause or fixational pause. The expectancy time of perception during the fixational pause has been handled only as a secondary component in reading. Yet, the temporal factor involved in any intellectual function must be appreciated and taken into account as having a very definite affect on performance. The complexity of the reading process involves a number of basic factors. Among them is the process of perception and within this process lies a phenomenon of time which seems to be directly related to read-

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9 Miles A. Tinker, "Diagnostic and Remedial Reading, 11," Elementary School Journal, Vol. 33, issue of January, 1933, p. 346-357.

10 Matthew Luckiesh, "The Perceptual Span in Reading," Optometry, Vol. 6, issue of 1953, p. 18-19.

11 Helen M. Robinson, Why Pupils Fail in Reading, Chicago, University of Chicago Press, 1946, xiii-257 p.

12 Arthur I. Gates, "Relation of Handedness, Eye-Sighting, and Acuity Dominance to Reading," Journal of Educational Psychology, Vol. 27, No. 6, issue of September, 1936, p. 450-456.

ing performance.

Not infrequently youngsters are found, at the academic level of learning basic skills, who have average or better intelligence, have no visual maladjustments, and have the proper incentive to read, yet are unable to cope with the material presented to them. It would seem then that if an investigation of the areas of intelligence, neurophysiology, and emotional disturbances, do not contribute a significant answer to the problem of reading disability, one should investigate a hypothesis dealing with the correlation of reading disability and perceptual factors. Should this be the case, the postulate formulated would be that there is no significant difference in tachistoscopic perception between good and poor readers.

1. Intelligence and Reading Ability

With the understanding that reading is a complex reaction to printed symbols involving cerebral process, and that intelligence is an outward manifestation of these complex processes, it would appear reasonable to suppose that a relationship exists between them.

Studies are continually being published of the relationship of intelligence to reading ability. In 1922,

McCall[13], listed subnormal intelligence as a cause of reading failure. Gray[14], also at that time, mentioned the fact that it was well proven that mentally defective children are unable to learn to read, but that on the other hand, there are many children of low native intelligence who have sufficient capacity to learn to read effectively, but who fail because they do not receive appropriate instruction. Witty and Kopel[15] reported a correlation of about .60 between reading test and intelligence test scores. They felt that this correlation was too low to predict one from the other. They pointed out that perhaps the low correlation between these tests was due to the fact that one test measured only reading, while the other included "arithmetical problem solving, memory of digits, perception of absurdities, and other relationships, motor performances, and so forth."

Monroe and Backus[16] concluded from their investigations that reading tests show a rather high correlation with

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13 William A. McCall, How To Measure in Education, New York, Macmillan, 1922, p. 109-111.

14 William S. Gray, et al, "Remedial Cases in Reading: Their Diagnosis and Treatment," Supplementary Educational Monographs, No. 22, Issue of 1922, p. 12.

15 Paul Witty and David Kopel, Reading and the Educative Process, Boston, Ginn, 1939, p. 226.

16 Marion Monroe and Bertie Backus, Remedial Reading: A Monograph in Character Education, Boston, Houghton Mifflin, 1937, xi-171 p.

intelligence tests. They found conclusive evidence showing that children who were retarded in general intelligence were usually similarly retarded in reading. Morphett and Washbourne[17] reported correlations of from .50 to .65 between Binet mental age and ability to learn to read. They indicated that the correlation between the scores on the Detroit test and reading were still higher.

More evidence has been obtained that the correlation between ability and reading comprehension is high, and this evidence is confirmed in fairly recent studies by Assum and Levy[18], Barbe and Grilk[19], Clark[20], Lennon[21],

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17 Mabel V. Morphett and Carleton Washbourne, "When Should Children Begin to Read?", Elementary School Journal, Vol. 31, Issue of March, 1931, p. 496-503.

18 Arthur L. Assum and Sidney J. Levy, "A Comparative Study of the Academic Ability and Achievement of Two Groups of College Students," Journal of Educational Psychology, Vol. 38, No. 5, issue of May, 1947, p. 307-310.

19 Walter Barbe and Werner Grilk, "Correlations Between Reading Factors and IQ," School and Society, Vol. 75, No. 1941, issue of March 1, 1952, p. 134-135.

20 Willis W. Clark, "Evaluating School Achievement in Basic Skills in Relation to Mental Ability," Journal of Educational Research, Vol. 46, No. 3, issue of November, 1952, p. 179-191.

21 Roger T. Lennon, "The Relationship Between Intelligence and Achievement Test Results for a Group of Communities," Journal of Educational Psychology, Vol. 41, No. 5, issue of May, 1950, p. 301-308.

Thomas[22], Townsend[23], and Wheeler[24]. At the same time the correlation between intelligence and reading rate tends to be comparatively low. For example, Barbe and Grilk reported that the correlation between Henmon-Nelson IQ's and the total scores on the Iowa Silent Reading Test for a group of tenth grade pupils was .72, whereas the correlation between IQ and reading rate was only .12. A point brought out by Townsend's report was that where separate verbal and numerical scores are obtained on a test of mental ability, the verbal scores, as one would expect, are much more closely correlated with reading comprehension scores than are the numerical scores.

A summary of the results of most investigators seem to show agreement on two main points. First, that inadequate intelligence appeared to be a factor in learning ability in all school subjects, of which reading was but one area; and second, in children who had specific reading disabilities, intelligence seemed to be distributed essentially as it is in the general population. That is to say,

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22 George I. Thomas, "A Study of Reading Achievement in Terms of Mental Ability," Elementary School Journal, Vol. 47, No. 9, issue of September, 1946, p. 28-33.

23 Agatha Townsend, "Reading and Achievement Test Scores in the Elementary Grades," Educational Records Bulletin, No. 45, p. 54-58.

24 Lester R. Wheeler, "The Relation of Reading to Intelligence," School and Society, Vol. 70, No. 1816, issue of October 8, 1949, p. 225-227.

severely retarded readers may be found with low, average, or superior intelligence. The only points of difference found among the various investigators, concerning the relationship between intelligence and reading ability, is the degree of this relationship and the identification of one as cause and the other as effect.

2. Neurophysiological Factors

Central Aspects -- Various theories of the relation between the brain and the body have been explored since the beginning of the history of medicine. According to Head[25], it was first suggested that a local brain injury could disturb the use of language. Weisenburg and McBride[26] say that this work was carried further by Gall, who attempted to localize memory "centres," by Bouillard, who developed the theory that certain functions were dependent on certain areas of the brain. Robinson[27] refers to specialists, such as Broca, Marie, Bastian, and Morgan, who related reading disabilities, along with other language inefficiencies, to neurological disorders.

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25 Henry Head, Aphasia and Kindred Disorders of Speech, Vol. 1, New York, Macmillan, 1926, xvi-549 p.

26 Theodore Weisenburg and Katherine E. McBride, Aphasia, New York, Commonwealth Fund, 1935, xvi-634 p.

27 Helen M. Robinson, Why Pupils Fail in Reading, Chicago, University of Chicago Press, 1946, xiii-257 p.

Among the theories that have had most attention relating to cerebral functions is one advanced by Dr. Samuel T. Orton[28]. Up to about 1925, considerable credence was given to an explanation of marded reading disability set forth by Hinshelwood[29], an English physician, late in the nineteenth century. Hinshelwood, having noted a certain similarity between pathological cases of loss of reading ability in mature persons known as "word-blindness," and cases of inability to learn to read on the part of children, suggested that these children were "congenitally word-blind," and thus the term "congenital word-blindness" began to be used and continued in rather common use for several decades.

About thirty years ago, however, Orton advanced his now well-known theory of the relationship between cortical dominance and confusion in learning to read. Up to the present, reading specialists are by no means in agreement concerning Orton's theory, but it unquestionably has had the therapeutic effect of transferring attention from the "congenital word-blindness" theory, which carried the implication that cases of extreme disability in reading were probably hereditary and consequently rather static and

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28 Samuel T. Orton, Reading, Writing, and Speech Problems in Children, New York, Norton, 1937, 215 p.

29 James Hinshelwood, Congenital Word-Blindness, London, Lewis, 1917, ix-112 p.

hopeless, to a point of view that these cases are functional and therefore susceptible to treatment.

During recent years, there seems to have been somewhat less intense interest in the question than there was during Orton's lifetime, but a number of articles and studies concerned with dominance and left-right orientation continues to be published. The numerous investigators considering the neurological basis for reading disability have produced conflicting results. Among the investigators who found evidence favoring the theory are Eames[30], Tinker[31], Teegarden[32], Bennett[33], and Gates and Bond[34]. Tinker summarized the information on dominance when he concluded that it is justified in inferring that both left-eyedness and tendencies to sinistra sequences in the perception of

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30 Thomas H. Eames, "The Anatomical Basis of Lateral Dominance Anomalies," American Journal of Orthopsychiatry, Vol. 4, No. 10, issue of October, 1934, p. 524-528.

31 Miles A. Tinker, "Diagnostic and Remedial Reading, II," Elementary School Journal, Vol. 33, issue of January, 1933, p. 346-357.

32 Lorene Teegarden, "Clinical Identification of the Prospective Non-Reader," Child Development, Vol. 3, issue of 1932, p. 357-361.

33 Chester C. Bennett, "An Inquiry into the Genesis of Poor Reading," Teachers College Contributions to Education, No. 755, issue of 1938, p. 84-90.

34 Arthur I. Gates and Guy L. Bond, "Relation of Handedness, Eye-sighting, and Acuity Dominance to Reading," Journal of Educational Psychology, Vol. 27, No. 9, issue of September, 1936, p. 455-456.

words and letters are due to cerebral dominance. Bennett found, after careful dominance tests of 50 cases of reading disability, that there was evidence that children of mixed dominance had a tendency to be poorer readers than those of consistent dominance.

Several others investigated dominance and found no evidence to support Orton's theory. Among them are Crider[35], Jenkins, Brown, and Elmendorf[36], Hildreth[37], Wolfe[38], Woody and Phillips[39], and Mintz[40]. Crider's main criticism of Orton's theory is that it could only be tentative, since enough is not as yet known about the course of the nerve

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35 Blake Crider, "The Lack of Cerebral Dominance as a Cause of Reading Disabilities," Childhood Education, Vol. 10, issue of February, 1934, p. 270-278.

36 D. L. Jenkins, Andrew W. Brown and Laura Elmendorf, "Mixed Dominance and Reading Disability," American Journal of Orthopsychiatry, Vol. 7, issue of January, 1937, p. 72-81.

37 Gertrude Hildreth, "Bilateral Manual Performance: Eye Dominance and Reading Achievement," Child Development, Vol. 11, issue of 1940, p. 311-317.

38 Lillian S. Wolfe, "Differential Factors in Specific Reading Disability, 1. Laterality of Function," Journal of Genetic Psychology, Vol. 58, first half, issue of March, 1941, p. 56-62.

39 Clifford Woody and Albert J. Phillips, "The Effects of Handedness on Reversals in Reading," Journal of Educational Research, Vol. 27, issue of 1934, p. 662-671.

40 Alexander Mintz, "Reading Reversals and Lateral Preferences in a Group of Intellectually Subnormal Boys," Journal of Educational Psychology, Vol. 37, No. 11, issue of November, 1946, p. 487-501.

fibers related to visual function or cerebral dominance. Hildreth found in her studies that generalizations about the relationship between handedness and reading difficulties have been based on insufficient evidence and not enough observations for statistical reliability. Jastak's[41] criticism of Orton's theory is well taken. He says that the theory was based on deductive reasoning rather than induced from the facts. His evaluation points out that Orton saw a group of symptoms and was explaining them neurologically, using theory rather than research findings as a basis for conclusions.

As we see them, various theories relating neurological phenomenon have been advanced to explain reading disability, but none of them have been proved. Although there is no general agreement, nevertheless, the relationship between the cerebral cortex and reading can be recognized as one of several possible causes, and therefore should be considered in studying a child's reading problem.

Peripheral Aspects — A second aspect of the neurophysiological factors and one closely related to reading is visual acuity, most commonly defined as sharpness or keenness of vision. Visual acuity measures form sense, the

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41 Joseph Jastak, "Interferences in Reading," Psychological Bulletin, Vol. 31, No. 4, issue of April, 1934, p. 244-272.

sense by which form is recognized. The common method of measurement is to determine the smallest letter that can be read at a distance of twenty feet. A visual acuity of 20/20, which is considered average, simply means that at twenty feet the observer can read a letter 8.86mm. square with details that are one-fifth the over-all size. Actually, it may be adequate vision; but the average observer should have better than 20/20 acuity. However, low visual acuity is not statistically important as a cause of reading failure. Its incidence is about the same in groups of good and poor readers, although it certainly is important in individual cases.

The question of the relationship of visual defects to reading disability has long been the subject of a good deal of debate and a certain amount of research. Opthalmologists were among the first to study reading disability, and since research on the movements of the eye pointed to possible visual problems, a great deal of emphasis has been placed on visual disturbances as a cause of failure to learn to read. Betts[42] and Fendrick[43] studied

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42 Emmett A. Betts, "Visual Aids in Remedial Reading," Teachers College Contributions to Education, No. 656, issue of April, 1936, p. 108-110.

43 Paul Fendrick, "Visual Characteristics of Poor Readers," Teachers College Contributions to Education, No. 652, issue of 1935, p. 47.

children in Grades 2 and 3 who were reading disability cases and who had no deficiency in general intelligence. They found significant differences favoring good readers that indicated better than normal visual acuity in the control group as compared to the poor readers. Selzer[44] tested the visual acuity of poor readers with that of an unselected group. His findings gave evidence that visual acuity is less adequate among poor readers than among normals. Bing[45] summarized his research findings concerning the influence of reading achievement and visual acuity and reported conclusive evidence of a high positive relationship between them.

On the other hand, Eames[46] studied 114 reading disability cases and 143 unselected cases of approximately the same ages and found no statistically reliable difference in the visual acuity of the two groups. Monroe[47] concluded

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44 Charles A. Selzer, "Laterial Dominance and Visual Fusion," Harvard Monographs in Education, No. 12, issue of 1933, p. 7-21.

45 Lois B. Bing, "A Critical Analysis of the Literature on Certain Visual Functions Which Seem to be Related to Reading Achievement," Journal of the American Optometric Association, Vol. 22, No. 3, issue of March, 1951, p. 454-463.

46 Thomas H. Eames, "Comparison of Eye Conditions among 1,000 Reading Failures, 500 Ophthalmic Patients, and 150 Unselected Children," American Journal of Ophthalmology, Vol. 31, No. 5, issue of June, 1948, p. 713-717.

47 Marion Monroe, Children Who Cannot Read, Chicago, University of Chicago Press, 1932, p. 80.

from her investigations that inadequate visual acuity was not a very frequent cause and did not distinguish the poor reader from the other groups of children. Farris[48] and Taylor[49] studied two-thousand pupils in the elementary grades. In summarizing their findings they stated there was little relationship between visual acuity and reading efficiency. Stulken[50], also, confirming Farris's results, concluded that visual acuity did not seem to be a primary factor in producing reading difficulty.

In summarizing the literature on the relationship between visual acuity and reading, one finds a variety of differences. Some writers maintain that there is no relationship while others take the opposite view and suggest that visual disturbances are largely responsible for reading disabilities. Still others have implied that visual acuity and poor reading may have a common cause, while another group believes that visual acuity is one of the many factors which may be operative in any case of reading disability. Seeing, as we know it, is a complex act wherein the optical

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48 L. P. Farris, "Visual Defects as Factors Influencing Achievement in Reading," Journal of Experimental Education, Vol. 5, No. 9, issue of September 1936, p. 58-60.

49 Earl A. Taylor, Controlled Reading, Chicago, University of Chicago Press, 1937, 367 p.

50 Edward H. Stulken, "Retardation in Reading and the Problem Boy in School," Elementary English Review, Vol. 14, No. 5, issue of May, 1937, p. 179-182.

system of the eye takes light emanating from the object and forms an image on a light-sensitive layer, the retina. Reading, on the other hand, is a central process. It takes place in the brain, the particular location being an area of symbolization, in which letters, word forms, digits, and numerical expressions are interpreted. When reading occurs in these specific areas, it must be remembered that the brain is dependent on impulses from the environment which makes perception possible. In other words, the brain has nothing to perceive and comprehend unless some sensory mechanism is first affected by an external stimuli. From this, therefore, we cannot neglect considering vision in the individual diagnosis of the poor reader, without implying, however, that visual acuity is the prime etiological factor of reading disability.

3. Emotional Disturbance

If the premise is accepted that the child needs to be considered as a whole person and not as a series of departmentalized problems, then there must be considered in this wholistic approach another important factor in the manifestation of reading disability, namely, emotional problems. Educators, psychologists, and teachers are showing an increased awareness of the relationship between a child's emotional pattern and his reactions in the learning

situation. More specifically, greater attention is being given to the emotional problems present in severely retarded readers. Studies in this field have led investigators such as Gates[51] to say "personality maladjustments or emotional tensions appear in all cases of reading difficulty or even in all cases of very serious disability or failure." Careful observations of symptoms have been reported by many writers.

In a psychiatric study by Sherman[52] of a number of poor readers evidence was given that the most common reactions were indifference to failure with compensatory interests in other areas: withdrawal of efforts, antagonism to academic problems with defense reactions, and refusal to improve reading as a bid for further attention. Gann[53] carried on a controlled study with school children to obtain evidence on the question of whether or not reading disabilities are an aspect of the total personality of the pupil and obtained evidence that indicated an affirmative answer to the question.

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51 Arthur I. Gates, "The Role of Personality Maladjustment in Reading Disability," Journal of Genetic Psychology, Vol. 59, first half, issue of September, 1941, p. 82-89.

52 Mandel Sherman, "Emotional Disturbances and Reading Disability," Supplementary Educational Monographs, No. 49, 1939, p. 132-133.

53 Edith Gann, Reading Difficulty and Personality Organization, New York, Kings Crown Press, 1945, p. 131, 133.

Jackson[54] studied the psychological, social and environmental differences between 300 advanced readers and 300 retarded readers. Among his results, he found that fears, worries, and the like existed among retarded readers to a degree that merited special attention in connection with reading difficulty.

Nine research studies having to do with emotional factors in reading retardation were reviewed by Raines and Tait[55]. They concluded that in many cases reading retardation is a symptom of emotional illness of the individual. Robinson[56] presented cases illustrating the interrelationship between emotional problems and reading retardation, and discussed therapy for maladjusted pupils with serious reading difficulties.

Witty[57] presented results of research studies which provided confirming evidence that personality difficulties and reading disabilities are related. In another study by

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54 Joseph Jackson, "A Survey of Psychological, Social, and Environmental Differences between Advanced and Retarded Readers," Journal of Genetic Psychology, Vol. 65, issue of September, 1944, p. 113-131.

55 Shirley Raines and Arthur T. Tait, "Emotional Factors in Reading Retardation," California Journal of Educational Research, Vol. 2, issue of March, 1951, p. 51-56.

56 Helen M. Robinson, Why Pupils Fail in Reading, Chicago, University of Chicago Press, 1946, p. 80.

57 Paul Witty, "Reading Success and Emotional Adjustment," Elementary English, Vol. 27, issue of May, 1950, p. 281-296.

this same investigator[58] attention was called to the value of reading in meeting emotional and developmental needs and promoting adjustment. In a comparative study of the reading achievement and personality maladjustment of superior and inferior readers, Stewart[59] found individuals among both groups who were basically insecure. In this study Stewart made an observation worth noting, namely, that apparently inferior readers could afford not to fear the consequence of their poor reading, while superior readers seemed to value their achievement mainly for the status that their superiority gives them with their associates.

Many other studies which consider the relationship between emotional problems and reading disability could be cited. However, one can conclude from summarizing most all of them as a group, that there is strong indication that reading difficulties and personal maladjustment are interrelated; but, there seems to be no clear-cut evidence with regard to which one is cause and which one is effect. Solkos states, in discussing what research has to say about emotional factors in reading retardation, "In many cases, intense emotional strain and reading disability seems to

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58 Paul Witty, "Reading to Meet Emotional Needs," Elementary English, Vol. 29, issue of February, 1952, p. 75-84.

59 Robert S. Stewart, "Personality Maladjustment and Reading Achievement," American Journal of Orthopsychiatry, Vol. 20, issue of April, 1950, p. 410-417.

interact, each adding stress to the other."[60] This point of view finds support in the research and interpretation of research studies by such well-known authorities as Robinson[61] and Russell[62]. Russell called attention to the need for further study of the positive relationship between reading achievement and personality adjustment.

4. Perception Relating to Reading

Research on the relation of perceptual skills to reading ability have, in general, used one of two different types of measures of perception. One type, as used by Gates[63], Sister Mary (of the Visitation)[64], Stroud[65],

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60 Helena H. Solkos, "What Research Says About Emotional Factors in Retardation in Reading," Elementary School Journal, Vol. 51, issue of May, 1951, p. 512-518.

61 Helen M. Robinson, Why Pupils Fail in Reading, Chicago, University of Chicago Press, 1946, xiii-257 p.

62 David H. Russell, "Reading Disabilities and Mental Health: A Review of Research," Understanding the Child, Vol. 16, issue of January, 1947, p. 24-32.

63 Arthur I. Gates, "A Correlational Study of a Battery of Reading Diagnostic Test," Journal of Educational Research, Vol. 15, issue of February, 1947, p. 436-447.

64 Sister Mary (of the Visitation), "Visual Perception in Reading and Spelling," Educational Research Bulletin, Vol. 4, issue of January, 1929, p. 3-48.

65 J. B. Stroud, "Rate of Visual Perception as a Factor in Rate of Reading," Journal of Educational Psychology, Vol. 36, issue of November, 1945, p. 487-498.

Potter[66], and Buswell[67], involves a series of paper-and-pencil perception tests which require the subjects to distinguish between pairs of similar and dissimilar items including words, nonsense syllables, geometric figures, and digits. The Perception section of the SRA Primary Mental Abilities Test[68] further exemplifies this measure of perception. These tests also include the task of selecting one specific element from a number of almost identical elements. They are administered with time limits, and the results are generally referred to as measures of speed of perception. The consensus of the above investigations is that there is a significant relationship between rate of visual perception as measured by these tests and reading ability. The degree of relationship varies with the content of the test. Perception for word forms shows the highest relationship, while perception of nonverbal items such as digits and designs shows no appreciable association with ability to read. In light of this, it would seem most reasonable to use nonverbal types

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66 Muriel C. Potter, "Perception of Symbol Orientation and Early Reading Success," Teachers College Contributions to Education, No. 939, 1949, 69 p.

67 Guy T. Buswell, "The Relationship Between Rate of Thinking and Rate of Reading," School Review, Vol. 59, issue of September, 1951, p. 339-346.

68 The SRA Primary Mental Abilities Test is used to give a measure of the child's mental ability, of his powers of visual and auditory discrimination, and of his language ability.

of stimuli to investigate tachistoscopic perception between groups that essentially vary in reading ability.

The second type of test involves the use of a tachistoscope for exposing various visual stimuli and asking the subject to report what he saw. As defined by Tinker[69], the total number of items — letters, digits, letter spaces — perceived and reported from an exposure which is too short to allow for more than one eye fixation is the individual's span of perception. Buswell[70], Litterer[71,72], Robinson[73],

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69 Miles A. Tinker, "Visual Apprehension and Perception in Reading," Psychological Bulletin, Vol. 26, issue of April, 1929, p. 223-240.

70 Guy T. Buswell, "How Adults Read," Supplementary Educational Monographs, No. 45, Chicago, University of Chicago Press, 1937, p. 3-158.

71 Oscar F. Litterer, "An Experimental Analysis of Reading Performance," Journal of Experimental Education, Vol. 1, issue of September, 1932, p. 28-33.

72 ————, "An Experimental Study of Visual Apprehension in Reading," Journal of Applied Psychology, Vol. 17, issue of June, 1933, p. 266-276.

73 Francis P. Robinson, "The Tachistoscope as a Measure of Reading Perception," American Journal of Psychology, Vol. 46, issue of January, 1934, p. 132-135.

Harris[74], and Sutherland[75], all investigated the problem of eye fixation and span of perception. Investigations of this type have utilized digits, letters, words, phrases, sentences, as well as form and color presentations for visual stimuli. These investigators indicate that there is a positive relation between perception span for words when related words are presented as stimuli and the size of fixations in normal reading. However, they do not answer the question concerning the relation of tachistoscopic perception, eliminating the factor of fixation by the presentation of one singularly projected stimuli, and reading ability. Their exposure times were of too long durations to permit a measure of what could be perceived in a single fixation. Freeburne[76], Sutherland[77], and Gates and Cason[78] used words and phrases

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74 Theodore L. Harris, A Laboratory Study of the Relation of Selected Factors to the Span of Recognition, in Silent Reading, Chicago, University of Chicago Press, 1941, 144 p.

75 Jean Sutherland, "The Relationship Between Perceptual Span and Rate of Reading," Journal of Educational Psychology, Vol. 37, issue of September, 1946, p. 373-380.

76 Cecil Max Freeburne, "Influence of Training in Perceptual Span and Perceptual Speed Upon Reading Ability," Journal of Educational Psychology, Vol. 40, issue of October, 1949, p. 321-352.

77 Op. cit.

78 Arthur I. Gates and Eloise B. Cason, "An Evaluation of Tests for Diagnosis of Ability to Read by Phrases of 'Thought Units'," Elementary School Journal, Vol. 46, issue of September, 1945, p. 25-32.

for their visual stimuli. These measures may be used to study the relationships between tachistoscopic span for words and reading ability, but not the relationship between tachistoscopic perception and reading ability.

Coleman[79] found that for a large majority of cases studied, perceptual retardation was a significant factor in reading disability. However, in answering the question, what conditions bring about retardation in perceptual development, Coleman divides children suffering from reading disabilities into four clinical groups, without, however, substantiating this grouping with experimental evidence. Among these groups he mentions youngsters overfocused interest in one specific area thereby leading him to an unequal differentiation of the perceptual field in which a small area becomes highly differentiated while other areas of the field remain relatively unstructured or undifferentiated. Another possible cause, according to Coleman, is that some children have been negatively conditioned to areas of perceptual discrimination, as for example, in the case of ambitious parents who put a great deal of pressure on their children before their reading readiness. The result is a state of anxious helplessness similar to what is known as catastrophic reaction accompanied by avoidance reaction to such required perceptual

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79 James C. Coleman, "Perceptual Retardation in Reading Disability Cases," Journal of Educational Psychology, Vol. 44, 1953, p. 497-503.

discrimination. A third possible cause of perceptual retardation is what Coleman calls the "visual type" child who uses mainly his eyes as a mediator between himself and reality; and the "haptic type," who relates to reality primarily through contact and kinesthetic sensations. The last cause mentioned by Coleman is the youngster with emotional problems.

A full review of the research on measures of reading ability would become a major investigation in itself, and lies far beyond the limits of the present work. Several factors involved in the measurement of reading achievement, however, must be considered in light of perception. In silent reading there are two essential variables; namely rate and comprehension. The relationship between these two variables varies with the age of the readers, the kinds of materials used, and the methods of measurement employed[80,81,82].

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80 Miles A. Tinker, "Rate of Work in Reading Performance as Measured in Standard Tests," Journal of Educational Psychology, Vol. 36, issue of April, 1945, p. 217-228.

81 Thorston R. Carlson, "Effect of Certain Test Factors on Measurement of Speed of Reading," Journal of Educational Research, Vol. 19, issue of March, 1951, p. 543-549.

82 J. B. Stroud and Margaret Henderson, "Rate of Reading and Learning by Reading," Journal of Educational Psychology, Vol. 34, issue of April, 1943, p. 193-205.

Although Bloomers and Lindquist[83] report rather wide ranges in correlations, -.47 to .92, most of the coefficients reported between rate and comprehension are positive but low. Preston and Botel[84] obtained a significant correlation between rate and comprehension measured under time limits; the relationship between rate and comprehension measured without time limits was not significant. They concluded that rate and comprehension are relatively independent.

Stroud[85] investigated the relationship of the rate of visual perception and reading rate. He used the Chapman-Cook Speed of Reading Test and six tests of visual perception with 507 pupils in Grades 4, 5, and 6. He found a correlation of about .50 between reading rate and rate of visual perception. This correlation agreed with that of other investigators. Though Stroud's correlation proved to be significant, the data showed a non-linear

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83 Paul Bloomers and E. F. Lindquist, "Rate of Comprehension of Reading: Its Measurement and Its Relation to Reading," Journal of Educational Psychology, Vol. 35, issue of November, 1944, p. 449-471.

84 Ralph C. Preston and Morton Botel, "Reading Comprehension Tested under Timed and Untimed Conditions," School and Society, Vol. 74, issue of August, 1951, p. 71.

85 J. B. Stroud, "Rate of Visual Perception as a Factor in Rate of Reading," Journal of Educational Psychology, Vol. 36, issue of November, 1945, p. 487-498.

relationship. Buswell[86], in his research in visual perception and tachistoscopic work, points out the difference between recognizing single words presented tachistoscopically and the process of reading. He feels that the improvement in reading from tachistoscopic work is explained in the changed character of the perceptual experience, that is to say, centrally rather than peripherally. Buswell contends that reading is a process of direct association between perceptual stimulus and meaning.

In summarizing, we have considered five main areas of possible influence relating to reading ability: intelligence, which was found to be directly related to reading ability, though the degree of this relationship is still undecided as well as its position as a cause or effect of reading ability; neurological aspects, which were found to be influential enough to be seriously considered in diagnosing reading disability cases; visual acuity, about which investigators seemed to sharply find conflicting evidence; emotional problems which some studies found to be the cause of reading disability, while other studies concluded that they were the result of reading disability; and lastly, perception, which is still in need of more precise investigation in order to determine its direct relationship with reading disability.

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86 G. T. Buswell, "Perceptual Research and Methods of Learning," The Scientific Monthly, Vol. 64, issue of June, 1947, p. 521-526.

It is with this last area, perception, that the writer wishes to further investigate. The cognitive processes involved in normal reading is intimately related to the entire perceptual aggregate. Therefore, it is reasonable to assume that some reading disability is caused by faulty perception. The present research will be concerned specifically with the investigation of the relationship of one element in the perceptual process, that of time, and reading ability. To test the relationship of temporal perception and reading ability unrelated symbols will be exposed tachistoscopically to good and poor readers. With such a design, the writer can test the null-hypothesis that there is no difference in temporal perception between good and poor readers.

CHAPTER III

EXPERIMENTAL DESIGN

As previously stated, the purpose of this study is to test the relationship of tachistoscopic perception between good and poor readers. If temporal perception is not a crucial factor in reading ability, then there will be no essential difference in this temporal factor between the two groups tested.

1. Measuring Instrument

To measure the temporal factor, the instrument used was that which was utilized in most other studies attempting to explore this problem, namely the tachistoscope. In this study the tachistoscope is used for two essential reasons. First, it is an adequate instrument for the type of measurement needed in this research, and secondly, a research project should be designed in such a way that it can be comparable to other research projects in the field.

The tachistoscope was originally developed as a device for the accurate measurement of the span of apprehension. Sir William Hamilton, in 1859, did the first crude experimental work on the problem of the number of objects that could be perceived at one glance. Up to that time the problem had been considered one of a philosophical

nature and had been disputed. Hamilton exploded the existing theory of a fixed span by showing it was a matter of individual differences.

The first step toward experimental control was taken by Jevons in 1871. For the purpose a number of black beans were thrown into a small box. The moment the beans came to rest, the subject was to estimate their number. Jevons' results showed a steadily declining curve in apprehension span as the number of objects presented was increased. In 1895 a tachistoscopic apparatus was adapted by Cattell to use in span and reading experiments. It was Cattell who laid the groundwork for both experimentation and training in the field of reading and reading problems.

The device which was used to obtain the measures of tachistoscopic perception in this study was the Keystone Overhead Slide Projector with a Flashmeter. This machine, with its exposure-control device is employed to flash simple and geometric forms, digits, words, and all types of symbols at speeds up to one-hundreth of a second. By gradually increasing the speed of the flash, and likewise introducing new stimuli of equal difficulty, the temporal perception of a single stimulus can be measured.

For the present investigation all exposures were made with shutter settings of 1, 1/2, 1/5, 1/10, 1/25, 1/50, and 1/100 seconds. It was assumed that any uncontrollable

fluctuations in exposure time varied at randon and thus did not significantly influence the results of the tachistoscopic test.

The slides which were used for the flash exposures were selected from the Basic Forms Series and from the Geometric Forms Series[1]. From each series, seven forms were arbitrarily picked, each of which would be projected on a screen at a preselected time. For each of the forms chosen an alternate one was also selected in case some mishap would occur to invalidate the first form. The forms taken from the Basic Series were approximately 1-1/8 of an inch when projected onto the screen, while the forms from the Geometric Series were approximately 3/8 of an inch when projected on the screen.

Since distance from the screen and angle of vision to the screen are factors which may influence the perception of an exposure, the tachistoscopic tests were administered to one subject at a time. The chair on which the subject sat was placed at a distance of nine feet directly in front of the screen. The projector was placed on a table immediately behind the subject. The room was semi-darkened and a light-meter reading was taken with each subject. A General Electric light meter was used. The mean reading was 5.5 foot-candles, with a $\pm$ of .2 foot-candle variation. In

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1 See Appendix, p. 68 and p. 69.

the research reporting maximum illumination necessary for producing fastest perception for reading bookprint, an intensity of greater than three foot-candles was not necessary. The screen used was 30" x 40" and of the beaded type.

2. Procedure

Each subject was provided with a pencil and paper in order that he or she might graphically describe the stimuli as perceived. The operation of the tachistoscope was explained to each subject, and several trial exposures were presented. Each subject was given the same instructions:

> I am going to show you some things on the screen one at a time. I want you to look carefully and after you have seen it, you may draw it on the paper I have given you. Be sure you draw it just the way you see it on the screen.

At this point the trial exposures were given. Prior to each exposure, the experimenter gave a "ready" signal by saying, "all right, read, one, two." After the word, "two," the shutter was tripped. The position of the stimuli on the screen varied from time to time; however, before each exposure, the experimenter clearly pointed out the exact location for each stimulus. In this way, there was greater assurance for minimum amount of eye movement.

After each exposure, the subject was asked to draw exactly what he saw and how he saw the object on the screen.

There were no limits set on the time taken by the subject to draw his reproductions. Each response was scored, without the subject's knowledge, on the scoring sheet[2] as either right or wrong.

3. Subjects and Their Selection

Though largely ignored in many previous psychological studies, the relationship between the experimenter and the subjects seems to be an essential factor. We are dealing after all not with inanimate objects, and not with animals, but with human beings who will in some manner react to the experimenter in a manner that is both emotional and intellectual. In dealing with human beings it is important that the cooperation of the subjects be assured without letting them know the reason of the experiment. This cooperative attitude is designated here by the term of rapport. The Dominion Achievement Test was administered by the experimenter himself to establish this rapport in addition to obtaining a measure of reading ability, a factor that was used in the selection of the individuals to be used in the project.

The subjects used in this study were obtained from the elementary school level, and more specifically, from grades two to five, inclusive. The population of the entire

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2 See Appendix, p. 70.

school is atypical with respect to home environment and mental potentialities. More than half of the children come from professional homes and over a third come from the homes of successful business men.

As mentioned above, in order to obtain a measure of reading ability, as one means for obtaining the sample for the study, all the pupils from the second grade through the fifth grade were given the Dominion Achievement Test[3]. This test consists of three parts: Part I, a vocabulary test, part II, a reading test, and part III, an arithmetic test. Part III was administered but was irrelevant for this study. A worth-while feature of this test is that separate, as well as a composite, score could be obtained for parts I and II. The achievement test was administered to all the pupils on a group basis.

Since intelligence is a major factor in reading ability, as mentioned in the previous chapter, each member of the experimental group was paired in respect to intelligence with a member of the control group. The scores from the SRA Primary Mental Abilities Test[4] for the two groups were used as an IQ index. Since it was observed that a

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3 Ontario College of Education, Toronto, Ontario, Dominion Achievement Test, Copyright 1943, Canada.

4 L. L. Thurstone and Thelma G. Thurstone, Primary Mental Abilities Test, Chicago, Science Research Associates, 1948.

reading factor in this test might reduce the score of the experimental group, the IQ index from the Standford Binet Intelligence Test, Form M, of the experimental group was compared with the PMA score of the control group[5]. For the control and experimental groups respectively, the mean IQ was 111.65 with a range of 98-129, and 112.56 with a range of 98-136. The mean IQ for all pupils throughout the second, third, fourth, and fifth grades was 115.

After obtaining an experimental group, chosen from the low scores on parts I and II of the Dominion Achievement Test, and having paired the IQ scores as mentioned above with a control group, the two groups were next paired according to their sex. This seemed to be an important factor in light of what was found in the literature. Those who have studied the possibility of a sex difference in reading have found that girls are consistently superior to boys throughout the elementary grades.

Next, the two groups were paired with respect to age. The mean age of 9 years 2 months, with a range of 7.10 years to 11.2 years was obtained for the control group, and for the experimental group a mean age of 9 years 2 months, with a range of 7.9 years to 11.2 years. The writer felt that although pairing the two groups according to IQ, sex,

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5 The coefficient of correlation between the PMA and the Standford Binet is .73.

and age, decreased the number for his sample population, nevertheless, the sacrifice was worth the precision thus obtained.

Further screening for both groups took the form of an individual case study. The first step was to scrutinize the cumulative record of each case. These records included the child's achievements in his grades, reports of social adjustment, and other observations which would help to screen the youngsters with emotional problems. Records of visual acuity tests were obtained from the files of the school nurse. It was necessary to identify anomalies interfering with reading progress as determined by previous studies. All the subjects in both groups had a visual acuity of 20/20. Again the number of subjects in the sample population decreased after the screening for this factor. In the final analysis, a total of twenty-three paired subjects were used for the experiment proper.

To summarize briefly, this writer, in an attempt to investigate whether or not a relationship existed between temporal perception and reading ability, designed an experimental study by which perception time might be measured tachistoscopically. The subjects used in the study were two groups of elementary school children ranging from the second through the fifth grades. The two groups were paired with respect to sex, age, and IQ. The essential difference

between the two groups was in their reading ability, the experimental group being significantly poor in reading. Other factors which could influence reading efficiency, such as visual acuity, neurological aspects, and emotional problems, were seriously considered in the critical selection of the sample population.

A tachistoscope with flashmeter attachment was used to measure temporal perception. Each subject, in the sample population, was individually exposed to the same two sets of stimuli. Each stimulus of each set was presented at a particular shutter time, seven speeds in all. For each time-exposure, the subject illustrated with pencil and paper what he saw. Each response was scored by the examiner as either right or wrong.

CHAPTER IV

DELIBERATION AND CONSEQUENCES

Now that the experimental design and procedures have been presented, it seems appropriate at this point to present the results and apply them to differences in tachistoscopic perception, the basic hypothesis of the research problem.

1. Presentation of Results

The sample population in this study was equated with respect to those factors considered most important in influencing reading ability. The one variable that differentiated the two groups before the tachistoscopic work was their reading efficiency compared on the basis of an achievement test in reading.

Differences between the two groups in tachistoscopic perception is shown in Table I. The *t* test was used to test whether the experimental and the control groups were alike or not alike in respect to temporal perception. An examination of Table I indicates there were no significant differences between the two groups at speeds slower than 1/10 of a second. Further inspection of this table reveals that the levels of confidence increased in significance as the shutter speeds increased. From the evidence shown in Table I it could be logically assumed that the two

Table I. - *t* Values and Levels of Confidence at Different Shutter Speeds

Shutter Speed in Seconds	Obtained *t* Value	P
1	—	—
1/2	1.00	.40
1/5	1.00	.40
1/10	2.15	.05
1/25	2.47	.05
1/50	2.62	.02
1/100	5.48	.001

groups would differ significantly at shutter speeds exceeding 1/50 of a second. That is to say, if the flashmeter had additional calibrations between 1/50 of a second and 1/100 of a second, experimentation at these additional intervals would no doubt show significant differences between the two groups. However, because of the limitations of the flashmeter used, we can conclude only that the two groups differ with respect to tachistoscopic perception most significantly at the 1/50 of a second level and at the 1/100 second level.

With regard to the Basic Forms slides which provided the large series of stimuli, the only significant difference between the two groups was at the speed of 1/100 of a second. The *t* ratio at this level was 2.47, with a P of .05. The fact that this series of stimuli did not show the same significant differences as did the geometric series is accounted for in its size. The Basic Forms series was actually atypical in size, and therefore did not have threshold discrimination[1,2]. That is to say, the size of the symbols of the Basic Forms series were too large when pro-

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1 Miles A. Tinker and Donald G. Paterson, "Readability of Newspaper Headlines Printed in Capitals and in Lower Case," Journal of Applied Psychology, Vol. 30, issue of April, 1946, p. 161-168.

2 ——— ———, "Readability of Mixed Type Forms," Journal of Applied Psychology, Vol. 30, issue of December, 1946, p. 651-657.

jected on the screen. Because of their gross size they had little if any value with respect to visual discrimination; and, because of their size when projected, there entered a possible factor of distortion.

An analysis of the statistical treatment used with the data must first be preceded by an explanation of how the data was obtained. Individuals from the experimental group were paired, as mentioned in the previous chapter, with those of the control group on the basis of those traits that correlate with measurements on which the two groups are being compared. Each response that was given by each subject was scored on an individual scoring sheet[3] as either a right or wrong answer. Numerically, then a subject would receive for each response either a I or 0. In other words, for each shutter time a score was obtained for each member of each group. Table II illustrates the preliminary statistical method for the scoring of the two groups at 1/50 of a second. In this table we find the difference in responses between the paired groups (C-E) given in algebraic signs.

Now we can go further for a more complete statistical analysis of the data. If we sum the differences (D) obtained and divide by N, we obtain the mean of the differences, which is equal to the difference between the means. Since we wish to obtain a *t* ratio, which in turn will lead

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3 See Appendix, p. 70.

us to finding out whether these groups differ significantly, we first calculate the standard error of the mean of these differences, using the formulae

$$1)\ \sigma_D = \sqrt{\frac{\Sigma D^2}{N} - \left(\frac{\Sigma D}{N}\right)^2}$$

and

$$2)\ \sigma_{MD} = \frac{\sigma_D}{\sqrt{N-1}}$$

To calculate the t ratio we divide the mean of the differences by the standard error of the mean of the differences:

$$t = \frac{Dm}{\sigma_{Dm}}$$

To further illustrate the statistical method used in this research the following calculations are shown using the data in Table II:

$$1)\ \sigma_D = \sqrt{\frac{\Sigma D^2}{N} - \left(\frac{\Sigma D}{N}\right)^2}$$
$$= \sqrt{\frac{9}{23} - \left(\frac{7}{23}\right)^2}$$
$$= \sqrt{.391 - .092}$$
$$= \sigma_D .547$$

$$2)\ \sigma_{Dm} = \frac{\sigma_D}{\sqrt{N-1}}$$
$$= \frac{.547}{\sqrt{23-1}}$$
$$= \frac{.547}{4.69}$$
$$= .116$$

$$3)\ t = \frac{Dm}{\sigma_{Dm}}$$
$$= \frac{.304}{.116}$$
$$= 2.62$$

Table II. - Performance of Sample Population with Geometric Forms Series at 1/50 Second

Pairs	Scores		C-E	
	Control	Exper.	(D)	D^2
# 1	1	1	0	0
# 2	1	0	1	1
# 3	1	0	1	1
# 4	0	1	-1	1
# 5	1	1	0	0
# 6	1	0	1	1
# 7	1	1	0	0
# 8	1	0	1	1
# 9	1	0	1	1
#10	1	0	1	1
#11	1	1	0	0
#12	1	1	0	0
#13	1	1	0	0
#14	1	1	0	0
#15	1	0	1	1
#16	1	1	0	0
#17	1	1	0	0
#18	1	1	0	0
#19	1	0	1	1
#20	1	1	0	0
#21	1	1	0	0
#22	1	1	0	0
#23	1	1	0	0
	Σ =22	Σ =15	ΣD =7	ΣD^2=9
	M=.956	M=.652	M_d=.304	

A sample of 23 pairs of subjects would be regarded as a "small sample," thereby justifying the use of the *t* ratio. In the example shown on page 55 with 22 degrees of freedom, a *t* of 2.62 is significant at the .02 or 2% level. It should be noted that since the correlation between the two groups is highly positive, the correct σDm would be smaller and the correct *t* ratio would be larger. Since the *t* ratio in the example cited is significant, we can be sure that the *t* we would obtain by taking into account the positive correlation would be even larger. This, of course, would also apply to the other *t* ratios that are significant in Table I.

2. Discussion of Results

The results thus obtained present enough evidence of a pertinent nature to justify our formulating certain conclusions. First, there is a relationship between tachistoscopic perception and reading ability. This is evidenced by the progressive and consistent differences obtained between the control and experimental groups; differences which showed that the good readers were able to perceive single stimuli more accurately at faster tachistoscopic speeds than were the poor readers. This is clearly illustrated in Table I which shows that the level of confidence increases with the increase of the shutter speeds. Thus, the element of "time"

as related to perception is a point of differentiation, and a significant one, between good and poor readers. From this, then, we can state that there is a difference in tachistoscopic perception between good and poor readers, and therefore, reject the null-hypothesis which was formulated at the beginning of this research.

A second conclusion derived from evidence in this study points to the fact that reading disability can be a manifestation of some anomaly in the perceptual process, and that the temporal aspect of this process expresses the anomaly. Here we are not speaking of slow reading, or lack of span, nor is the former attributed to the latter. It is the writer's contention that the reader normally has span to burn. The reason why he does not make greater use of his visual capabilities is that at each fixation the eye will take in only as much as the mind will comprehend. Further evidence on this point is to be found in the fact that, generally, an individual will read familiar material more rapidly than he will read unfamiliar or difficult material. It would seem that in the case of reading the unfamiliar or difficult material, the eyes must, in effect, "mark time" while the mind is "catching up" with them or comprehending what the eyes are perceiving. One should keep in mind, of course, that the basis for visual sensation is a point-to-point projection from the retinae to the occipital cortex.

This is the basis for the visual sensation evoked by the objects, but the final awareness of the assembly of objects involves considerably more nervous activity than a mere point-to-point projection. As a result of this activity we appreciate what we have already termed as a perceptual pattern. The primary visual sensation, resulting from stimulating the visual cortex, is integrated with sensations from other sources presented simultaneously and, more important still, with the memory of past experience.

It would seem reasonable to conclude that rate is, in the main, determined by rapidity with which meaning is aroused after the words are seen; that is, it is not a matter of getting the material to the brain, but of assimilating it after it gets there. To reiterate, this assimilation has a temporal element, inherent in the perceptual process, which accounts for the speed of the total perception.

In summarizing, the evidence here indicates that the integrating process of the mind consumes time; that a time element exists in the integrating process of perception, and furthermore, that this time element is not the same from person to person. If we acknowledge individual temporal differences in the perceptual process, although fundamentally the process is similar in its mechanisms from person to person, then we can assume that there is actually a delay in both of our groups, but that the delay is simply less in the

one than in the other. With the knowledge that efficient reading is dependent on a full and rich perceptual integration, we can better appreciate how reading disability could be manifested by a weakness in this perceptual process, that is, when the temporal delay is relatively long. The problem which still exists, and which deserves further research, is one of cause and locus of delay.

SUMMARY AND CONCLUSIONS

The primary purpose of this research study was, essentially, to investigate whether or not there existed a difference in tachistoscopic perception between two groups of elementary school pupils who differed only in regard to their reading ability. Previous studies in the field of reading ability did not always stress the perceptual elements involved in the skill, and few of these gave due consideration to the importance of perception time. Nor do studies in perception, vastly covered in the literature, seem to give due consideration to the temporal aspects within the cerebral operations implied in the total perceptual process. Although some psychologists did conduct experiments in the psychological laboratory relating to reaction time and other time measurements of mental phenomena, relatively little has been done with respect to the element of time in perception and the specific nature of reading disability. From this design the writer hoped to find out if a relationship existed between the speed of perception, which in effect would represent a time element in perception, and reading ability. Since the two groups in the study were equated with regard to all factors, but one, pertinent to reading efficiency, it could be concluded that if a tachistoscopic difference was found between them then the difference would be dependent upon the speed of perception, or time-perception. The basis on which the two groups were not equated, of course, was their

difference in reading ability. The results obtained unmistakingly indicated a difference in tachistoscopic perception between the two groups. Not only were the differences significant at the fastest shutter speed, 1/100 of a second, for both sets of stimuli, but, with the smaller stimuli series the results were significant from 1/10 of a second, and at the 1/100 second speed the level of confidence was greater than .001.

From the present study implications can be drawn of what might be done for reading disability cases of the type presented here. For example, early training in developing greater perceptual acuity, perhaps by tachistoscopic means, might help the potential reading disability cases. Also, being aware of the importance of perception in the learning process, teaching methods and materials might be devised to benefit the individual from a point of view of perceptual integration. Furthermore, the fact cannot be denied that the individual's total personality, the unique order which he establishes in relation to reality, is to a large degree dependent upon his perceptual process. Thus, the more we know and understand about the mechanisms involved in the total perceptual process, the better able we will be in coping with remedial techniques, and develop preventive methods, in the field of psychology in general.

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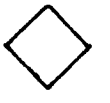
APPENDIX 1

Geometric Forms Series

	S1	Alternate
1 sec.		
1/2		
1/5		
1/10		
1/25		
1/50		
1/100		

APPENDIX 2

Basic Forms Series

1

.2

.5

.10

.25

.50

.100

APPENDIX 3

Scoring Sheet

STUDENT:

PATTERN:

	Time in Seconds						
	1	.2	.5	.10	.25	.50	.100
L1							
L2							
L3							
L4							
L5							
L6							
L7							
S1							
S2							
S3							
S4							
S5							
S6							
S7							

ABSTRACT OF

Temporal Perception of Good and Poor Readers

The purpose of this study was to investigate whether or not there existed a difference in tachistoscopic perception between two groups of elementary school pupils who differed only in regard to their reading ability. The two groups of children, ages 7.10 to 11.2, were matched with respect to intelligence, sex, age and grade placement. Other factors which could influence reading efficiency, such as visual acuity, neurological aspects, and emotional problems, were seriously considered in the critical selection of the sample population.

A tachistoscope with flashmeter attachment was used to measure temporal perception. Each of the forty-six subjects in the population was individually exposed to the same two sets of stimuli. Each stimulus of each set was presented at a particular shutter time, seven speeds in all. For each time-exposure, the subject illustrated with pencil and paper what he saw. Each response was scored by the examiner as either right or wrong.

The study was based on the null-hypothesis that if temporal perception is not a crucial factor in reading ability, then there will be no essential difference in this temporal factor between the two groups tested. The results obtained unmistakingly indicated a difference in tachisto-

scopic perception between the two groups. Not only were the differences significant at the fastest shutter speed, 1/100 of a second, for both sets of stimuli, but, with the smaller stimuli series the results were significant from 1/10 of a second, and at the 1/100 second speed the level of confidence was greater than .001. The statistical method used was the *t* test which served to show whether or not the experimental group and the control group were alike in respect to temporal perception.

The results thus obtained present an important implication in the fields of psychology, psychophysiology, and education. Namely, that since the two groups in the study were equated with regard to all factors, but one, pertinent to reading efficiency, it could be concluded that the tachistoscopic difference found between them is dependent upon the speed of perception, or time-perception.

CORRECTION OF THE ERROR IN INTERPRETATION OF THE T-TEST IN TEMPORAL PERCEPTION BETWEEN GOOD AND POOR READERS

The interpretation of the t-test on page 57 beginning with the third sentence in the first paragraph is in error. The error was in the writer's assumption that the quantity $\sigma_{DM} = \sqrt{\sigma_{M_1}^2 + \sigma_{M_2}^2}$, which was used in the statistical work, was separate and apart from the quantity $\sigma_{DM} = \sqrt{\sigma_{M_1}^2 + \sigma_{M_2}^2 - 2r\sigma_1\sigma_2}$. This is not the case. Actually, the quantity $\sigma_{DM} = \sqrt{\sigma_{M_1}^2 + \sigma_{M_2}^2}$ includes the idea of the second quantity shown here. Therefore, it cannot be said that the t-score would be larger if the positive correlation was to be taken into account, for this correlation was already included in the formula $\left(\sigma_{DM} = \sqrt{\sigma_{M_1}^2 + \sigma_{M_2}^2}\right)$ which the writer used. Thus, the statements presented from the third sentence of page 57 to the end of that paragraph are unnecessary since they do not apply to the results obtained in the experimental design[1].

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1 Personal communique with J. P. Guilford, Professor, University of Southern California, and A. L. Atkinson, Professor, University of California at Los Angeles.

Performance of Sample Population with Geometric Forms Series at 1/10 Second

Pairs	Scores		C-E (D)	D^2
	Control	Exper.		
# 1	1	1	0	0
# 2	1	1	0	0
# 3	1	1	0	0
# 4	1	1	0	0
# 5	1	1	0	0
# 6	1	1	0	0
# 7	1	1	0	0
# 8	1	1	0	0
# 9	1	1	0	0
#10	1	0	1	1
#11	1	1	0	0
#12	1	1	0	0
#13	1	1	0	0
#14	1	0	1	1
#15	1	1	0	0
#16	1	1	0	0
#17	1	1	0	0
#18	1	1	0	0
#19	1	1	0	0
#20	1	1	0	0
#21	1	1	0	0
#22	1	0	1	1
#23	1	0	+1	1
	Σ=23	Σ=19	ΣD=4	ΣD^2=4
	M=1	M=.826	M_d=.174	

Performance of Sample Population with Geometric Forms Series at 1/25 Second

Pairs	Scores		C-E (D)	D^2
	Control	Exper.		
# 1	1	0	1	1
# 2	1	1	0	0
# 3	1	1	0	0
# 4	1	1	0	0
# 5	1	1	0	0
# 6	1	1	0	0
# 7	1	1	0	0
# 8	1	1	0	0
# 9	1	1	0	0
#10	1	0	1	1
#11	1	1	0	0
#12	1	0	1	1
#13	1	0	1	1
#14	1	1	0	0
#15	1	1	0	0
#16	1	1	0	0
#17	1	1	0	0
#18	1	1	0	0
#19	1	0	1	1
#20	1	1	0	0
#21	1	1	0	0
#22	1	1	0	0
#23	1	1	0	0
	Σ=23	Σ=18	ΣD=5	ΣD^2=5
	M=1	M=.782	M_D=.218	

Performance of Sample Population with Geometric Forms Series at 1/50 Second

Pairs	Scores		C-E (D)	D^2
	Control	Exper.		
# 1	1	1	0	0
# 2	1	0	1	1
# 3	1	0	1	1
# 4	0	1	-1	1
# 5	1	1	0	0
# 6	1	0	1	1
# 7	1	1	0	0
# 8	1	0	1	1
# 9	1	0	1	1
#10	1	0	1	1
#11	1	1	0	0
#12	1	1	0	0
#13	1	1	0	0
#14	1	1	0	0
#15	1	0	1	1
#16	1	1	0	0
#17	1	1	0	0
#18	1	1	0	0
#19	1	0	1	1
#20	1	1	0	0
#21	1	1	0	0
#22	1	1	0	0
#23	1	1	0	0
	Σ=22	Σ=15	ΣD=7	ΣD^2=9
	M=.956	M=.652	M_d=.304	

Performance of Sample Population with Geometric Forms Series at 1/100 Second

Pairs	Scores		C-E (D)	D^2
	Control	Exper.		
# 1	1	0	1	1
# 2	1	0	1	1
# 3	1	1	0	0
# 4	1	1	0	0
# 5	0	0	0	0
# 6	1	0	1	1
# 7	1	0	1	1
# 8	1	0	1	1
# 9	1	0	1	1
#10	1	0	1	1
#11	1	0	1	1
#12	0	1	-1	1
#13	1	1	0	0
#14	1	0	1	1
#15	1	0	1	1
#16	1	0	1	1
#17	1	0	1	1
#18	1	0	1	1
#19	1	0	1	1
#20	1	0	1	1
#21	1	0	1	1
#22	1	1	0	0
#23	1	1	0	0
	Σ=21	Σ=6	ΣD=15	ΣD^2=17
	M=.913	M=.261	M_d=.652	

Age, I. Q., Sex, and Grade of
Experimental and Control Groups

Name	Age		Grade		I. Q.		Sex	
	E	C	E	C	E	C	E	C
Aldous, Mary	10-7		5		108		F	
Carroll, Debbie		10-9		5		102		F
Arlett, Ian	8-4		2		111		M	
Groman, Phillip		8-1		2		112		M
Aubry, Britt	10-4		5		110		M	
Cohen, Allen		10-1		5		110		M
Beach, Ricky	8-2		2		119		M	
Scott, Brian		8-3		2		116		M
Berlin, Frank	10-5		5		107		M	
Lynn, Evan		10-6		5		111		M
Campbell, Doug	8-4		2		128		M	
Smellie, Jim		8-4		2		122		M
Ewing, Hector	10-2		5		136		M	
Osborne, Chris		10-3		5		129		M
Gowland, Sandra	9-0		3		98		F	
Magee, Cynthia		8-11		3		98		F
Greenberg, Janice	10-11		5		106		F	
Fairchild, Joan		10-11		5		104		F
Hayes, Fred	8-6		3		114		M	
McInnes, Simon		8-9		3		113		M
Heggtvit, Becky	9-9		4		107		F	
MacKenzie, Nan		9-9		4		101		F
Lorievo, Monique	8-10		3		109		F	
Mundy, Louise		9-0		3		116		F
MacKay-Smith, Mary	9-4		4		121		F	
Blyth, Mollie Ann		9-5		4		118		F
MacKay-Smith, Ricky	11-2		5		109		M	
Gray, Brian		11-1		5		110		M
McDougal, Peter	7-9		2		121		M	
Pedon, Blair		7-10		2		116		M
McClosher, Louise	9-3		4		101		F	
Reed, Sharon		9-6		4		109		F

Age, I. Q., Sex, and Grade of
Experimental and Control Groups

Name	Age E	Age C	Grade E	Grade C	I. Q. E	I. Q. C	Sex E	Sex C
Michael, Dan	9-3		4		99		M	
Davey, Alan		9-6		4		98		M
Miranda, Gilles	8-9		2		101		M	
Deyer, David		8-0		2		107		M
O'Conner, Michael	8-9		3		110		M	
Laidlow, James		8-11		3		110		M
Pickergill, Alan	9-0		3		120		M	
Wright, George		9-2		3		116		M
Skene, Jerry	8-0		2		125		M	
Stewart, John		7-11		2		128		M
Sommerfeld, Howard	9-9		4		115		M	
White, Paul		9-8		4		112		M
Vachone, Jeff	8-6		3		114		M	
Burrett, Ned		8-10		3		110		M
Total	201.125		202.1-2		2589	2566		
N=23 pairs								
Mean	9.2 yrs.		9.2 yrs.		1-2.56	111.65		
Range	7.9-11.2		7.10-11.2		98-136	98-129		

SUPPLEMENT TO

TEMPORAL PERCEPTION BETWEEN GOOD AND POOR READERS

Some of the readers to whom the main study was submitted agreed with the significance of the scores obtained from a sample population that was divided into an experimental and control group by means of the Dominion Reading Achievement Test, but questioned the validity of the design as a tool by which one may conclude that a significant difference exists closely relating scores on the reading test with tachistoscopic perception.

Because of the importance of this particular study and the possible influences it may have on educational methods in general and the teaching of reading in particular, a cross-validation experiment was decided upon. After considering several suggestions, the writer selected the negative form of the original experiment as the most applicable cross-validation method.

It will be recalled that in the main study the sample population for the experimental group was chosen on the basis of low achievement scores obtained on the Dominion Reading Achievement Test. Matched with this experimental group was a control group whose test scores were at least equal to their actual grade placement. Matching was done on the basis of age, sex, grade, and I. Q.

TEMPORAL PERCEPTION BETWEEN GOOD AND POOR READERS

In order to duplicate the experiment of the original study as closely as possible, the total population of a single school which was as atypical as the one from which the subjects for the original experiment were selected, consisting of 200 pupils, grades 2 through 5, were exposed to symbols presented to them tachistoscopically. From this population, 25 pupils were selected on the basis of their inability to accurately perceive all of the symbols. This experimental group was then matched on the same points as the matching in the original study, namely, age, sex, grade, and I. Q., with a second group of 25 except that this second group had not one single failure in perceiving tachistoscopically exposed symbols.

The Dominion Reading Achievement Test was then administered to this population of 50 subjects who for purposes of both reliability and validity were divided into class-grade groups. The hypothesis assumed for the cross-validation study was identical to the principle contained in the hypothesis for the original experiment, namely, that reading achievement does not vary significantly with the accuracy of tachistoscopic perception.

Measuring instruments and procedures were identical to those used in the original study.

TEMPORAL PERCEPTION BETWEEN GOOD AND POOR READERS

Table S-1 shows the ranges and means of ages and I. Q.'s of the sample population.

Differences between the experimental and control group in reading achievement is shown in Table S-2. The t test was used to test whether the two groups were alike or not alike in respect to reading ability. It will be noticed from Table S-2 that a numerical value of 1 or 0 has been assigned to each subject, paralleling, incidentally, the same type of evaluation used in the main study. This value is important for it represents a "pass" or "failure" of each subject with regard to his reading test. If on the reading achievement test a subject received a grade-placement score which was six months or more less than his actual grade placement, he was assigned a numerical value of 0. If the subject's reading score was not more than six months below his actual school-grade placement a value of 1 was assigned. It is important to mention here that all the members of the control group who obtained a rating of 1 received a score on the reading test at least equivalent to their grade placement.

On page 5 is shown the statistical treatment of the data leading to a t ratio. With 24 degrees of freedom, a t ratio of 7.157 was obtained. This is a highly significant value since a t ratio of 3.745 reveals a level of

Table S-I. - Range and Mean of Ages and I.Q.'s of Sample Population

	Control	Experimental
Age		
range	7.2-11.1	6.7-11.0
mean	9.2	9.1
I.Q.		
range	102-139	98-138
mean	118.5	121.6

confidence of .001.

$$\sigma_D = \sqrt{\frac{\Sigma D^2}{N} - \left(\frac{\Sigma D}{N}\right)^2}$$
$$= \sqrt{\frac{17}{25} - \left(\frac{17}{25}\right)^2}$$
$$= \sqrt{.680 - 462}$$
$$= \sqrt{.218}$$
$$= .467$$

$$\sigma_{DM} = \frac{\sigma_D}{\sqrt{N-1}}$$
$$= \frac{.467}{\sqrt{25-1}}$$
$$= .095$$

$$t = \frac{Dm}{\sigma_{Dm}}$$
$$= \frac{.680}{.095}$$
$$= 7.157$$

A cross-validation study to test the validity and reliability of the results obtained in the study Temporal Perception Between Good and Poor Readers shows that tachistoscopic perception is definitely related to reading achievement and is thus a valuable tool in facilitating the development of the potential intellect of the individual student. The hypothesis on which this study was based

Table S-II. - Ratings of Sample Population on Reading Achievement

Pairs	Scores		C-E (D)	D^2
	Control	Exper.		
# 1	1	0	1	1
# 2	1	1	0	0
# 3	1	0	1	1
# 4	1	0	1	1
# 5	1	0	1	1
# 6	1	1	0	0
# 7	1	0	1	1
# 8	1	0	1	1
# 9	1	0	1	1
#10	1	1	0	0
#11	0	0	1	1
#12	1	0	1	1
#13	1	1	0	0
#14	1	0	1	1
#15	1	1	0	0
#16	0	0	1	1
#17	1	0	1	1
#18	1	1	0	0
#19	1	0	1	1
#20	1	1	0	0
#21	1	0	1	1
#22	1	0	1	1
#23	1	1	0	0
#24	1	0	1	1
#25	1	0	1	1
	Σ=23	Σ=8	Σ=17	Σd^2=17
	M=.920	M=.320	Md=.680	

assumed no significant difference between tachistoscopic perception and reading ability. The results obtained indicate, however, that a significant difference does indeed exist and that this difference would not occur by chance more than once in possibly ten thousand times.

It is felt that as far as scientific generalizations can be made, a safe correlation may be postulated between tachistoscopic perception and reading ability.

APPENDIX 1

Age, Grade, I.Q. and Sex of Experimental and Control Groups

Name	Age		Grade		I. Q.		Sex	
	C	E	C	E	C	E	C	E
Doug	10-0		5		108		M	
Jonathan		9-7		5		122		M
Betsy	10-0		5		121		F	
Jeanette		9-7		5		116		F
Susan	8-9		4		111		F	
Olivia		9-2		4		96		F
Paul	9-5		4		127		M	
Robin		9-3		4		117		M
Helen	9-3		4		139		F	
Ronna		9-2		4		132		F
Stacy	8-5		3		124		F	
Debbie		8-4		3		124		F
Stephan	7-10		3		115		M	
Ralph		7-6		3		117		M
Philip	8-4		3		110		M	
Mark		8-2		3		100		M
Don	8-6		3		110		M	
David		8-2		3		113		M
Judith	7-2		2		113		F	
Chris		7-5		2		112		F
Paul	7-3		2		131		M	
George		7-4		2		138		M
Steven	7-5		2		115		M	
Olson		7-7		2		110		M
Verita	7-5		2		131		F	
Elizabeth		7-2		2		125		F

APPENDIX 1

Age, Grade, I.Q. and Sex of Experimental and Control Groups

Name	Age		Grade		I.Q.		Sex	
	C	E	C	E	C	E	C	E
Linda Melanie	7-5	6-11	2	2	103	104	F	F
Deborah Jean	7-6	6-11	2	2	127	115	F	F
Ralph John	10-9	10-10	5	5	122	123	M	M
Edward Alan	11-1	11-0	5	5	132	134	M	M
Daniel Chris	10-9	10-9	5	5	102	104	M	M
Timothy Samuel	10-8	10-10	5	5	109	111	M	M
Ann Jessica	10-9	10-9	5	5	132	133	F	F
Ronnie Paul	10-3	10-4	5	5	117	118	M	M
Brian Thomas	10-5	10-3	5	5	105	105	M	M
Barry Bruce	10-2	10-4	5	5	122	124	M	M
Debbie S. Patricia	10-2	10-3	5	5	103	107	F	F
Wallace Byron	10-3	10-3	5	5	133	138	M	M