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ABSTRACT

This bulletin is a compilation of papers dealing with the role of perceptual functions in reading and reading difficulties that were delivered at the 1966-67 Convention of the International Reading Association. Various sections are devoted to discussions of and reports of research on such matters as the auditory and visual modalities in reading, the neurological and psychological, and sociological aspects of perception in reading, and the relationships between personality, intelligence, perception and reading achievement. A final section discusses the application of research findings to instructional and diagnostic practice. (JH)

PERCEPTION AND READING

HELEN K. SMITH, *Editor*

University of Chicago

Volume 12, Part 4

Proceedings of the Twelfth Annual Convention

International Reading Association

Newark, Delaware

Foreword

INCREASINGLY, IRA is giving attention to the multidisciplinary aspects of reading instruction. This fact is reflected in the number of papers of multidisciplinary nature given at the annual convention, the related research reports given there, and the committee work that is going on. One particular area of concern is that of perception in the process of reading. Psychologists interested in both the normal and faulty workings of perception, pathologists, clinicians, and persons from various branches of the medical profession are contributing in various ways to IRA's program of work.

The 1966-67 convention of IRA in Seattle featured many notable papers related to perceptual processes in reading. This bulletin is a compilation of the papers which will be of special interest to all specialists in reading and helpful to teachers who wish to understand how perception functions in children's learning to read or in their having trouble in learning.

Helen K. Smith of the University of Chicago has given her expert attention to the editing of the papers and getting them in shape for publication in this accessory volume of the convention Proceedings.

MILDRED A. DAWSON, *President*
International Reading Association
1966-1967

The International Reading Association attempts, through its publications, to provide a forum for a wide spectrum of opinion on reading. This policy permits divergent viewpoints without assuming the endorsement of the Association.

Introduction

THE THEME of this bulletin reflects the widespread current interest in the role of perception in the reading process. *Perception and Reading* is comprised of papers which were prepared by specialists in different disciplines and were presented at the Twelfth Annual Convention of the International Reading Association in Seattle, Washington, in May 1967.

This bulletin has been divided into seven parts and includes reviews of research, reports of studies in perception, and suggestions for the application of research findings, especially in beginning reading. Although the writers are cognizant of the many factors involved in perception as related to reading, they have found it necessary to limit their discussions to certain aspects of the problem.

Part one introduces the reader to the general concept of modality and is followed by parts two and three which emphasize the auditory and visual modalities as applied to reading. In addition to the reviews of research concerned with vision and young children, auditory modality and reading, and visual modality and reading, a diagnostic plan for the evaluation of auditory abilities is presented. The study by Rosen and Ohnmacht is concerned with the relationship of perception, readiness, and reading. Otto reports upon an investigation of color as an aid to paired-associate learning. Geyer's detailed study of the prediction of a temporal eye-voice span is included in this section.

Neurological and psychological implications of perception for reading are found in part four. Isom reviews the neurological research pertinent to reading; Whitsell describes the role of the neurologist in a team approach to reading problems. The purpose of the paper by Ayres is to relate research data in neurology to the child who has severe reading problems because his brain is not functioning normally.

Two papers in part five are concerned with perception as related to sociological aspects of reading.

Part six includes the reports of three studies of perceptual training and first grade reading achievement; one study of first grade reading instruction through auditory and visual methods for auditory and visual learners; and one study on the relationships of perception, personality, intelligence, and first grade reading achievement.

The final section includes papers in which Wittick and Aaron translate research in perception and reading into practice.

The papers in this volume add to the rapidly growing body of knowledge of the relationship of perception and reading. They should alert the reader to needed research in the foregoing complicated and important areas of learning.

HELEN K. SMITH, *Editor*

CONTENTS

The Modality Concept—Including a Statement of the Perceptual and Conceptual Levels of Learning*

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The intellectual life of man consists almost wholly in his substitution of a conceptual order for the perceptual order in which his experience originally comes. William James, *Essays in Radical Empiricism.*

IN A RECENT NEWSLETTER from a suburban Chicago special education group, the lead article dealt with learning disabilities and mental retardation. A plea was made that the schools recognize that "maturational lags or temporarily arrested development not be confused with low potential." The article continued with the statement that " . . . of every thousand American school age children, 150 will have learning problems, 30 will be mentally retarded, and 5 will have learning disabilities and mental retardation" (*8*). Whether or not the incidence figures quoted are correct, everyone is concerned about such children, especially those with normal intellectual potential who are underachievers.

Learning theories and learning theorists, whether biologically or environmentally oriented, have most often failed in their treatment of the foregoing issue. They have described the learning process as they see it but have failed to describe the child who must do the learning. They have rarely provided data on the evolution of individual differences in learning abilities of children. Literally, they have never given the reasons that, according to their theories, the underachiever underachieves.

The present paper is an attempt to rectify, at least in part, this neglect of a crucial aspect of learning. While it is not the statement of another learning theory, it does provide a *modus operandi* for learning; for example, how it is achieved and, therefore, why some children do not achieve when it seems as though they should. It also serves as a partial explanation of individual differences in the manner of learning. Through the approach advocated, we hope to gain greater insights into the problems of the 15 percent of school children said to be underachieving.

The present paper deals with the initial stages of learning, especially the early steps taken by children as they develop the capacity to utilize their maturing neurological systems. It is not intended as a criticism nor as a support of any of the well-publicized theories of learning. It is, in fact, compatible with any or all of them.

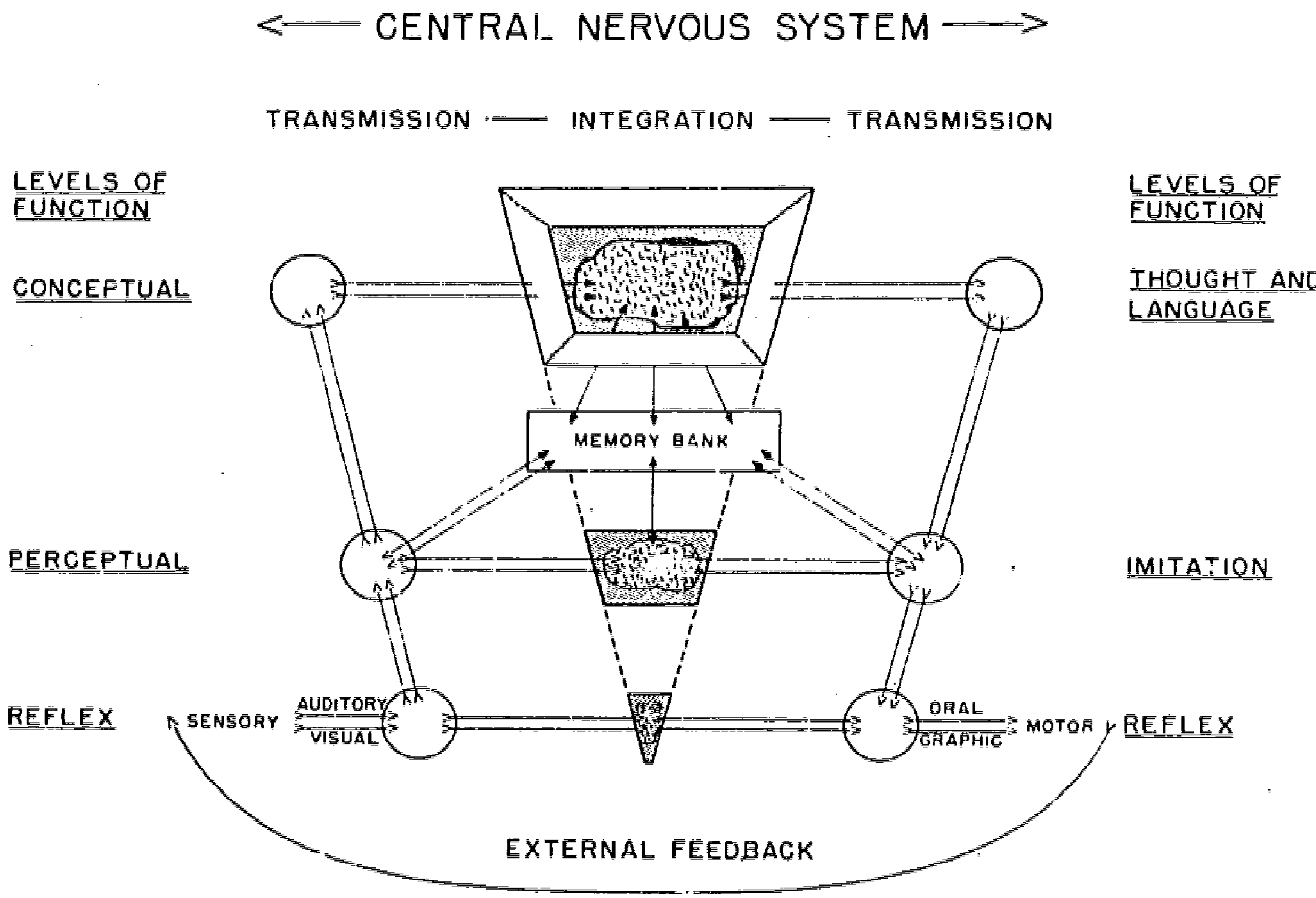
The hypothetical model presented in Figure 1 stresses two features of the structural base underlying the learning act. First, it emphasizes the unique modality-bound nature of all sensory input signals and all motor output patterns. Second, it elaborates the hierarchical, yet interrelated, nature of the maturation and development of the neural system. In this regard, it parallels what is known of the physiological maturation of the central nervous system.*

Figure 1 is designed to illustrate both the modality-bound nature of the input and output signals and the increasing levels of complexity of function as the individual matures. The modality-bound nature of children's learning behavior was initially recognized in the clinically observed fact that many children with learning problems appeared to have greater facility in using one input pathway than in using another and—an observation of.

*This study was partially supported by the Department of Health, Education, and Welfare, U. S. Office of Education, Project #2225.

*In the present context, *maturation* is used to describe the establishment of the neurological components necessary for sensory transmission, integration and motor transmission of signals within the nervous system. *Development* is reserved for the functional adaptation of an established neural pathway.

FIGURE 1



AN OPERATIONAL DIAGRAM OF THE LEVELS OF FUNCTION IN THE CNS

equal importance—they had considerably less facility along other pathways. The foregoing was seen most easily in children with known impairments of neurological structure, such as localized brain tumors or accidents affecting, for example, the transmission of auditory signals but not visual or tactual signals. Similar behavior, however, was seen in some children who had no demonstrable neurological impairment. The learning behavior of this group of children was so similar to that of the earlier group that even today they are sometimes, erroneously I believe, said to have "minimal brain impairment." As more children were studied from this modality point of view, it was apparent that a predilection for one sensory input channel over the others could be observed, regardless of whether a suspicion of organic impairment or pathology was present.

This observation seemed in keeping with the concept first suggested by Charcot, as reported by Freud (*1*), that each person has a particular modality of choice in learning, a typology of "audile," "visile," and "tactile" learners.

Phenomenological data for the division of people into learning types seem to abound in life. Toscanini is said to have *heard* every note of music he read. Picasso, on the other hand, is said to *see* in his own unique way even the sounds of animals in the field. People select occupations based upon a predilection for auditory stimuli (musicians) while others pursue the graphic arts (painting) because of visile-ness.

Clinical data from the handicapped learner or underachiever are equally omnipresent, if one is alerted to them. Some children have been known to be so deficient in auditory processing of signals that for most environmental situations they are functionally deaf even though their hearing acuity is quite normal. One such child was incapable of recalling a telephone number or a single item from a list of ten items read to him. Another could not distinguish the letters of the alphabet at twelve years of age yet suffered no loss of visual acuity. Studies of adult brain-injured subjects showed with clarity residual ability that was modality bound as they processed verbal stimuli. A factor analytic study of the responses of 168 adult aphasic patients to visual and auditory stimuli on the Language Modalities Test for Aphasia showed " . . . for all analyses (a single factor) was best defined by all items demanding oral response to visual stimuli, . . . while the oral response to auditory stimuli appeared as a separate factor" *(5)*.

The concept of differential use of the separate input pathways is no longer purely theoretical but is assuming the proportions of an acceptable fact about children and their learning.

The differential modality distinction appears to be related more closely to the innate capacity of a child than to any determinable environmental factor. No specific deprivation of stimulation could be found in the home or play environments of children with poor auditory learning or poor visual or poor tactile-kinesthetic learning. In fact, within the populations studied clinically, such children have been found to come from all types of homes, including the highly verbal university setting as well as the almost nonverbal disadvantaged environments. Some came from homes in which they were the only child and others from homes in which they were the eldest or youngest of multiple sibling groups.

For most children, the two major modalities seemed to reach a stage of equalization of function by age nine; that is, whatever lags in development were present seemed to be overcome by that time. Usually, however, the modality showing the most rapid development indicated the child's predilection. Perhaps from this fact it might be said that a modality matures because of some innate neurological tendency—for the audile child, the auditory pathway matures earliest; for the visile child, the visual pathway. With maturation, there is an accompanying developmental sequence—again, the earliest to mature nominates the earlier development of function. The audile child, then, not only matures earliest in an auditory sense but also develops his more mature pathway with the greater ease. Here, use of the pathway assists with its development. It comes to complete function and use at an early age. Practically, this conclusion would mean that both perceptual and conceptual function would develop early with consequent early and accurate acquisition and use of speech. The visual function of such an "audile" child could be either rapid or slow in its development. If it is rapid, reading would be accomplished easily; but if it is slow, reading might be delayed somewhat by the need for compensation to assist the auditory pathway. If the visual were very slow indeed, then reading might present a real block since only the auditory percepts would be available; and while reading is more than a visual skill, it does require vision.

The visile child would pose quite a different problem. If he is average in auditory learning, his reading might be slightly affected in the early school years. If, however, he is markedly slow in auditory perceptual development, high intelligence providing almost automatic compensation or the services of an alert and patient therapist would be helpful.

To understand the effect of modality preference on such skills as reading, speech, and spelling, one must not only be able to isolate the preferred modality but also be able to assess the level of achievement and the potential for training of whatever modality is delayed in its development.

While the emphasis here has been upon the development of visual and auditory pathways, the visuo-motor and moto-kinesthetic pathways need equal attention. In some ways they are perhaps the better attested of the developmentally related modality functions, as Frostig (3) and others have demonstrated.

Attempts to reduce the effect of a lag in developmental progression in any one of the modalities have been somewhat equivocal. Auditory training for children with slow development of such processes as discrimination, memory, and sequencing along that modality has produced good results in some children and failed to produce results in others. These are clinical data, however, and should be studied under the more rigorous analyses of research. Children with poor auditory discrimination who showed what was believed to be causally related speech articulatory inaccuracy failed to improve in auditory discrimination with directed training. On the other hand, children with inadequate auditory discrimination who had difficulty learning to read, again with supposed causal relationships, did indeed improve in discrimination with training.

The major importance of the modality distinction lies in the direction that it may give for assisting the underachiever. Too often the remedial reading teacher follows the same pattern in remedial work that the classroom teacher follows in general instruction. We have long assumed that a particular method or pattern for teaching or remediating the art or skill of reading was appropriate—whatever that method might be. The concept of differential modality proclivity would argue for tailoring the instruction and the remediation, especially the latter, to the capacity of the individual child. To illustrate the problems that arise when this tailoring is not done, consider the child who has an inadequate auditory perceptual ability as demonstrated by his incapacity to differentiate the sounds of the language, retain and recall them, sequence them properly, or associate them with previously learned visual or tactual-kinesthetic clues when he is faced by an instructional or remedial program based on the learning of phonics. Consider also the child who demonstrates a slower progression of his visual skills than is expected of him and who is faced by a school-system approach that fosters sight training. In either instance, the failure to recognize the differential modality distinctions for these children almost foredooms them to failure in achievement of reading. While the foregoing may affect in a major sense only a minimum of the children who are underachievers, it may be partially at the base of a wide variety of other problems engendered by the original failure. Perhaps the entire thesis of the argument for considering the modality distinction can be most succinctly stated as providing a way of understanding the underachiever. If, indeed, he can be seen as a child who is underachieving because of some real modality distinction, then programs can be developed that will be of assistance to him.

To this date, attempts to predict reading problems from results on prior perceptual testing have been less than rewarding. While it is true that a greater number of children with poor reading achievement than with average reading achievement showed poor visual and auditory discrimination and memory, the number of false positives has made the prediction an unlikely one. However, at the time when poor reading achievement can be identified, the presence of poor visual or auditory perception can point the way to directed remediation.

The second important aspect of the model presented as Figure 1 is the time-bound progression of the neural system building each succeeding layer upon previously developed layers both in the sense of maturation and development. The infant begins life with a mature and well-developed reflex system which soon differentiates into a bridge permitting the flow of environmentally induced signals which proceed from input through integration to output. At this stage, psychologically, only recognition is achieved, not comprehension. At this level of behavior, the child learns to imitate and echo his environment. He learns to discriminate the sounds of the language he hears and later to differentiate the letters and other forms that he sees. Finally, he develops his highest level of neural behavior: he receives, integrates, and expresses signals from a variety of modalities with comprehension of the input; synthesizes and associates the interpreted signal with previous learning; and formulates an output signal with intent to communicate.

Two kinds of learning, then, are evident—the perceptual, prelinguistic, preoperational learning described most completely by Piaget and his followers as "sensory-motor learning" (*2*) and the more complex, conceptualizing type of learning with comprehension and intent. Attention in this paper is directed to the former, not because it is felt that this is the more important of the two but because it seems that there has been overemphasis on the latter for beginning learners of any new skill. This overemphasis has led to a tendency to focus on the child's attack on new learning at the conceptual level, frequently before the child has established a proper perceptual base for that learning. Werner and Kaplan (*9*) in their study of symbol formation pointed out that ". . . a fuller psychological insight into all representation, including linguistic, will be obtained only by operating on the assumption that linguistic representation emerges from and is rooted in nonlinguistic forms of representation."

The child having difficulty learning to read, it is here argued, may well be started at too high a level for him if comprehension is demanded before he has mastered the preverbal perceptual distinctions necessary for phonic interpolations. The development of the maturing perceptual level can be seen in the progressive achievement of such skills as discrimination, retention and recall of sounds and letters, sequential ordering of phonemes and graphemes, and the ability to interrelate one with the other.

To illustrate what it is the child must learn and be able to use at this pre-comprehension level of behavior, the act of auditory discrimination must be explored in detail. This auditory perceptual function is the ability to differentiate each sound of the language from every other sound of the language: at its grossest level, for example, the ability to separate vowels from consonants, then vowels from other vowels, and, finally, consonants from other consonants. Vowel discriminations are, for the most part, well accomplished by all but a handful of children by the end of the third year; yet everyone experiences some difficulty discriminating certain vowels from others when spoken. Did he say *pen* or *pin*? is a common adult question when the context does not provide a satisfactory clue. The difference between the *e* and *i* when used medially in a single syllable word is a minimal contrast of considerable difficulty. The distinctions between some consonants are equally difficult—*p* and *b*, for example, cannot be considered as within the differential speaking armamentarium of the child until he can listen to word pairs like *pat* and *bat* and *pin* and *bin* and recognize them as being different. The linguistic term for this recognition of difference is called the method of "minimal contrasts" (*4*). A growing body of research now points to the fact that this ability to form minimal contrasts is a developing process that goes on quite normally in children through their eighth year. Some children develop the ability early in life; their speech efforts reflect this early development. They speak accurately almost from the onset. They have the 'ear' to guide their speech attempts. Other children, however, develop this discriminatory ability more slowly and their speech accuracy often mirrors their development. Some children have difficulty with auditory discrimination throughout their lives and learn to speak with accuracy only by compensatory means.

Turning back to what has been said about Charcot's concept of learning typology mentioned earlier, the child with good intelligence but slow in development of auditory discrimination ability would undoubtedly need to be thought of as a "visile" child or perhaps "tactile" in his learning; the child who speaks early and accurately but later shows some difficulty acquiring the distinctions necessary for differentiating visual forms would most probably be "audile" or "tactile." Some children, of course, will be found who are slow at developing any of their perceptual skills, regardless of the modality involved. These children would need to be classified as mentally retarded since they would have no avenue open to them for learning; after all, that is what is meant by mental retardation—the inability to learn.

Stress needs to be placed in initial stages of learning on the perceptual level, or the later learning at the conceptual level may be faulty and without a basic structure upon which the child can develop his linguistic skills. Where a lag in the developmental process along any of the modalities can be determined, the remedial task seems most properly directed at that modality. If success cannot be achieved through such a direct approach, the teacher should turn to the other modalities since reading, like speech or writing or spelling, cannot be considered the product of any single modality but rather a confluence of them all. It is believed that this generalized attack through parallel alphabets is the source of the success achieved with such teaching approaches as the Initial Teaching Alphabet (*6*) which takes advantage of a common alphabet of sounds and letters. Similarly, the Illinois Test of Psycholinguistic Abilities (*7*) develops with considerable acumen the modality differential in language acquisition, especially at the conceptual level.

No brief is held here for or against any specific teaching method. It is believed that any method can be adapted to the purposes of modality distinctions or reduced to the level of perceptual function, if needed. Every teacher and therapist whose unlikely task it is to make every child literate must, at this time at least, be ingenious enough to provide the materials necessary for such teaching. Unless the writer's estimate of the commercial adjuncts to reading is in error, however, and unless the proposed approach to underachievement turns out to be totally unsuccessful, materials will be produced in great abundance.

In summary, this paper has stressed two factors—the differences among children in their use of specific modalities for learning and the necessary establishment of perceptual bases for conceptual learning. It is hoped that, at least for the child in need of remediation, education can take on the nature of a child-centered program and shift away from ready acceptance of automatization and conformity. While one speaks of education in the mass sense, it is the individual child who must learn. It is for his good that the ideas here proposed have been formulated.

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The Transfer from Modality Perceptual to Modality Conceptual

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EVEN WITH THE PRESENT state of limited knowledge possessed by psychologists, neurologists, linguists, and educators, the topic of the transfer from modality perceptual to modality conceptual would fill several thick volumes. The most that can be done in this paper, therefore, is to indicate to teachers and clinicians that there is more to reading than meets the eye. Current work in the area of language in neurology, linguistics, and psychology all seems to point to at least three, and probably many more, levels or areas of functioning.

The sensory level

The first level is the sensory, which includes hearing, seeing, movement sensing, and touching, as well as the primary areas of the cortex where the sensory signals are first received and, from the sensation aspect only, identified as having primary physical attributes, e.g., shapes, noises, colors, bulk. However, there is no recognition and still less understanding at this level. Neurologically, this sensory input is very likely decoded in this simple way in both the sense organs themselves and their respective primary cortical areas. These functions, which operate well even in babies, must obviously be intact if a child is going to learn to read in the usual way; yet many learning disability cases with primary neuro-sensory deficits remain undiagnosed. By the time a child learns to read, he has usually acquired a fully working auditory/vocal language; therefore, all he has to do is associate a visual code with this auditory/vocal *code*. However, many learning disability cases do not have a competent auditory/vocal language. Before examining this audiovisual linkage, the way in which auditory/vocal codes become associated with meaning will be discussed. In doing so *sound-label* (and later, *visual-label*) will be used rather than the ambiguous term *word*. These terms are, respectively, shorthand for the spoken or heard word and for the read or printed word, the latter representing the succession of phonemes which comprise the former.

The perceptual level

Much of the experience most people have throughout their lives is nonverbal even when verbal activity is going on coincidentally. One drives the car, watches television, listens to music, and plays sports. This direct experiential material is built up, some of it selectively from birth, coming in through the body and its senses into a main memory store to cooperate with other cognitive processes to cross index, superimpose, and freely associate the received images into concepts or meanings. Thus, when one sees a particular chair, he classifies it nonverbally as one of those single-seated pieces of furniture in which one adopts a specific relaxed posture. A nonverbal infant could conceivably not be acquainted with the sound-label *chair* and yet know its function. Thus, perception combines identified sensory input data with meaning or concept, the latter being a function of utilitarian attention or other survival-value experience. Neurologically, it is possible that this perceived meaningful material may in terms of memory be stored in what Penfield and Roberts (*8*) call the "interpretive cortex." They state: "Psychical responses may be called experiential or interpretive. They have been obtained . . . only from certain portions of the temporal lobe cortex in either hemisphere." Much of this experiential or perceptual memory bank is nonverbal in the strict linguistic sense. The unit of perception then, as an internalized composite of meaningful images, is termed a *concept*. More correctly, a percept is one type of concept, namely, one which involves an immediate sensing of the environment.

The conceptual level

A concept can be defined as an enduring (and most likely progressing) coalescence of related images usually in the form of a class (e.g., government, table, furniture). Whereas a percept must always involve an immediate meaningful interpretation of the environment, a concept may be manipulated internally without reference to the immediate nonverbal physical environment. If one ponders on a mental arithmetic problem or next year's vacation, he is *thinking*—that is, manipulating—concepts internally. Thought processes may take place with or without continuous or intermittent nonverbal percepts. A watchmaker repairing a watch resolves the problem on the basis of previous experience-built concepts under circumstances of acute visual perception. Conceptualizing (thinking) usually includes some form of reasoning, a process which involves the manipulation of the relationships between separate image-type concepts, (e.g., If I put the chair on the table, I will be able to replace the broken electric light fitting).

Symbols

A symbol can be defined as an "object" or "thing" which, being indelibly associated in the mind with another "object" or "thing" serves as a recall agent for the latter. A flag can symbolize national identity, and spoken words can symbolize almost anything. The important point is that the symbolic object is, in its own right, also a primary object which is sensed, perceived, and conceptualized. When these symbolic objects are verbal labels (symbols) of various types, one calls the percepts, concepts, and relationship reasonings which they represent a spoken language. Obviously, the purpose of symbolic systems, such as spoken language, is to enable men to communicate or to reason without having to manipulate real objects directly. Instead of showing people how to put the chair on the table to get to the broken light, someone can instruct them by the use of sound-label substitutes. Thus, the spoken word may facilitate conceptualizing but is not itself conceptualizing. Still less is verbal activity equatable with abstraction, which is a higher order conceptualizing process frequently visuo-spatial in modality, as for example in abstract art.

In the written form of languages is a system of secondary (visual) symbols representing the primary (auditory-vocal) symbols which in turn represent the perceived objects or coalesced concepts. These scondary (visual) symbols are also objects in their own right which are directly sensed, perceived, and conceptualized just as are both the primary auditory symbols and the original objects. Therefore, a written phonetic language expresses a sensory, perceptual, and conceptual system, the latter two being capable of symbolic expression through two symbolic systems.

The way in which the psychological imagery processes are cross-related with the two symbol systems is presented in some detail in table 1.

Symbol systems

Table 1 is largely self-explanatory if it is examined carefully. As one moves down the imagery or symbol system columns, their content, the vertical developmental processes, and the horizontal association processes become increasingly complex, a fact which is not surprising since the transition from the top left-hand sense-data corner to the lower righthand reading/reasoning corner parallels the likely psychological evolution of the human organism.

Although the developmental progression may sometimes appear to operate on a continuum from sensing to thought, probably it does not do so. It is highly likely (and at the sensory level fairly certain) that specific areas of the brain may take care of each psychological function, namely, sensing, memorizing (as an aspect of perceiving and simple conceptualizing) and thinking (*4, 6*). It is also probable that each of the two symbol systems, being of sensory origin, has its specific

TABLE 1

THE CLASSIFICATION OF IMAGES AND THEIR SYMBOL SYSTEMS BY TYPE OF PSYCHOLOGICAL PROCESS DURING DECODING OPERATIONS AND BY IMPLICATION SOME ENCODING OPERATIONS.

Psychological Process	Images of Objects Actions, etc. Nonverbal (Internalized)	Association Process	Primary Auditory Symbol System (Auditory Verbal)	Association Process	Secondary Visual Symbol System (Visual to Sound Verbal)
Sense Data Awareness	Unidentified image, e.g., an object wit'i a rectangular flat top, four legs, etc. (1)	No Association <—/ /—> / / (8)	The sensing of a series of sounds which have no concept associations although they may be perceived as unknown words, e.g., listening to an unknown langeage (12)	No Association <—/ /—> / / (19)	The visual sensing of a series of line configurations in patterned sequences, e.g., looking at a page of Chinese print as nonreaders (23)
Developmental Process	Familiarization through repeated sensing, usage teaching, etc. (2)		Auditory-sound decoding into images through learned contingencies (13)		Visual decoding of the printed word through learned associations with sound-labels (words) (24)
Percepts	Recognition of an immediately present object, action, etc. (or its pictorial equivalent) as something repeatedly experienced in different situations, e.g., something one works on, eats from, puts objects on. (3)	Learned-by-memory image to sound-label (word) pairing. Image and symbol have been repeatedly associated in experience. <——> (9)	Hearing a particular sound-label (word) or a simple string of such labels, and being able externally or internally to identify any image associated with that label, e.g., "See that TABLE" ——> identification (14)	Learned-by-memory gestalt printed word sequence patterns associated with relevant gestalt sound-labels. Or for beginner readers or new words grapheme to phoneme matching trials <——> (20)	The child beginning to read will learn to recognize (a) some whole visual word patterns as symbolizing a gestalt of sound (a word) and (b) some sequences of visually coded phonemes which he must blend. The ratio of (a) to (b) will depend on look-say to phonics teaching methods ratio, e.g., T-A-BLE. (25)
Developmental Process	Internal development through perception and memory of permanent integrated networks of image concepts all inter-associated. (4)		Internal development of grammatical coding systems linking sound labels—partly innate and partly mimicry (15)		The learning of visual grammatical sequences which more or less correspond with auditory sound label grammatical systems. (26)

TABLE 1 (continued)

THE CLASSIFICATION OF IMAGES AND THEIR SYMBOL SYSTEMS BY TYPE OF PSYCHOLOGICAL PROCESS DURING DECODING OPERATIONS AND BY IMPLICATION SOME ENCODING OPERATIONS.

Concepts	An internalized grouping of coalesced similar (or closely related) images within and across all sense modality experience. Concepts are usually generalized and form spatial and temporal hierarchical classes; e.g., these objects as a class have a flat working surface: leg(s) being mostly empty space beneath, i.e., a meaning without a symbolic label or representational concepts. (5)	(a) Automatic selection of context appropriate image-label associates; that is, sound labels pull out percept images or concept images. (b) Inasmuch as encoding takes place as an aid to decoding, one can say that the sound labels are more or less automatically grammatically sequenced. Both processes (a) and (b) are probabilistic and take place within a generalized concept; i.e., they are, in Osgood's terms, "homeostatic and qualifying" (Osgood, 1963) (10)<———>	Here there is a corresponding hierarchial classification of sound-labels possibly into Osgood's "Word Form Pools." Auditory closure operates in this system facilitated by familiarity of both concept and label and by the semi-automatic retrieval of habitual sequences of sound-label strings (phrases or sentences) *within* a particular concept class of images, e.g., the table is made of wood and has four legs. Thus some probabilistic prediction of sound-label and sequence is possible. (16)	Arbitrary printed word-sound label associations or arbitrary grapheme-phoneme associations of irregular orthography (in English). Also learned matched grammatical sequences of both sound and visual word labels, i.e., automatic grammar correspondence associations. <———> (21)	Good readers must be able to recognize (i.e., perceive and conceptualize) the gestalt of sound in a printed word label or else be able to "sound it out" if the word is unfamiliar. Visually coded labels (words and morphemes) in Visual Word Form Pools will correspond to (be associated with) their equivalent sound-label Word Form Pool Contents. Visual closure is facilitated both by familiarity and by the semiautomatic habitual letter and word sequences within their associated concept-idea-class-area. (27)
Developmental Process	Development of intellectual cognitive processes as studied and elaborated in the works of Jean Piaget. (6)		Development and understanding of sound-labels (words) for various relations possible *between* concepts. (17)		Development of visual label equivalent forms of relational sound labels. (28)
Thinking as a dynamic process of	Nonverbal nonsymbolic concepts and their interrelationships (which incidentally are	Probabilistic selection of sequential concept (image) sound-	To the above (16) sound-label selection processes can be added further relational sound-labels plus	Same as above in (21) but the sound and visual label associations and	The ability to decode conceptual meaning from the printed word using many complex associations on

manipulating interrelated concepts	higher order concepts) can be processed in accordance with the "thought-computer-programs" available. In other words, concepts can be sequentially reasoned with through time in accordance with the innate laws and acquired rules of thought; e.g., geometry. Note that lines, angles planes, etc., and their interrelationships are not symbolic, they are true visuo-spatial abstractions. Symbolism and abstractions are far from synonymous. Also note that images, percepts, concepts, and even their interrelational 'modifiers' can be visuo-spatial, auditory, kinesthetic-motor, tactile, taste, olfactory visceral, proprioceptive, temporal, or any combination or permutation of these.	label associates; i.e., syntactical stringing or decoding of such. This process would be, in Osgood's terminology, "multiplicative and quantifying." The selection of sound-labels in encoding or the thought process in decoding is also partly determined by the thinking program in use, i.e., the relationship associations *between* concepts. <———> (11)	those semi-habitual string sequences (sentences and phrases) which match the laws and rules of "rational" thought; e.g., legal terminology abounds with these sound-label sequences of a relational and interrelational type. On the other hand, original or unfamiliar thought-speech or listening or reading (29) is less habitual, less fluent, more hesitant. (Goldman-Eisler, 1964) (18)	their grammatical sequences are more complex in accordance with the relational concept system they symbolize. <———> (22)	several levels (all described in other sections of this table), e.g., reading a report of a scientific research project. This requires the reader to decode first in sound-label grammatical strings as described in (18). All verbally facilitated thinking, conceptualizing, or perceiving on any level, whether decoding or encoding, always utilizes auditory symbols. Even so, much thought is nonverbal, e.g., in art, science, and music. (7) But when one reads, he first decodes to the auditory stage and then uses sound-label language as the medium for thought. (29)

neurological territory. It is not a contradiction of the foregoing statements to say that all these neurological facets of the brain overlap and interlock in unbelievably intricate intercommunication systems. Psychologically, these are the association, control, and feedback processes through which the functioning of the parts is integrated. The higher functions, together with the complex symbolic labeling and sequencing they involve, usually incorporate all the lower levels in their operation. Even so, one can obviously think in the absence of immediate sensory stimuli.

The childhood development of conceptual imagery and thinking has been investigated by many people, notably Piaget. The work of the "symbolic" logicians is also relevant to the laws and rules of human thought. Although Osgood, Wepman, Kirk, and others have constructed excellent models for the hierarchical classification of language and conceptualizing processes, until recently no clear theoretical distinctions had been made between imagery/concepts and the two symbol systems. Osgood (1963) has analyzed the relationship between meaning and sentences, particularly from the syntactical psycholinguistic point of view. This approach with its "meaningless word form pools," "semantic key sorts," and "cognitive mixers," seems most fruitful if only because meaning or conceptualizing is theoretically distinguished from (and related to) words and syntax. Though Osgood explores cognition, semantics, and linguistics, he is not concerned with distinguishing between auditory- and visual-symbol systems, except to say very briefly once or twice that man does not speak the way he writes.

The essence of Osgood's thesis is that during the encoding of an assertion, non-word meanings selectively determine, on a probabilistic basis, the "choice" of words and their positional sequence. It is difficult, however, to determine if Osgood considers abstract conceptual thought possible in the absence of internalized signs or symbols. Inhelder and Piaget (1958) hold that logical thought processes are not founded in verbal symbols or linguistic material.

Before going on to the part played by the association, it is necessary to emphasize that in the interests of clarity and brevity the writer has vastly oversimplified both his conceptualizing of the whole topic and the neuropsychology involved. Many consider that the sensory-neurological "workings" of the brain most likely operate on a basis of a stochastic selection of bits of stored information of any and all kinds and of matching, integrating, decoding, and encoding them meaningfully. Visual and auditory imagery may even be stored in operationally different memory systems (*1*), the former perhaps being a "spot" or bit matching process, whereas the latter may be a more gestalt-unit sort of registration. This supposition would explain some of the real problems a few dyslexic children have matching a well-learned auditory/vocal language to or from its visual/written version. It also fits in with Osgood's contention that the word is the base unit of language and, by implication, that the concept is the base unit of thought.

Thinking, reasoning, and language

Although language is not thinking, it is a symbolic medium for facilitating, expressing, or communicating thought; it does so with varying degrees of accuracy. Sometimes, for example, when speaking quickly one chooses a word to express a concept even though he knows it is not an exact match. Nevertheless, since language—or more precisely, words, phrases, and sentences—roughly mirror thought processes, it is possible (as the symbolic logicians have done) to use them to study the nature of thinking. As thinking (i.e. conceptualizing and reasoning) cannot occur in a vacuum—one has to think about something—the total process involves one or more of the following: a) actual sensory external objects (the watch repairer situ-

-ation); b) the internal images of those objects (the artist who paints from memory or composer whose memory imagery is auditory; or the choreographer whose memory imagery is partially kinesthetic); c) primary auditory symbols (speaking and listening); or d) secondary visual symbols (reading and writing). All these, usually in various continuously shifting permutations and combinations, participate in thinking and reasoning, but only a) and b) can be the subject matter which is the content of the thinking. The thinking and reasoning aspect is a process of internally manipulating this content; the term *manipulating* is used because when actual objects, as in a), are represented as an immediate concept/content, they are often manipulated by the hands usually using tools (hammers, trucks, or radar) at the bidding of thought/reason. Apart from the image/concept content, what does thought/reason have which internally manipulates these? The answer is relationships in space-time involving active change wrought by some physical or biological agent or agents in the widest sense of those words. Note that the active-change may be zero because staticity is one extreme end of the change continuum. These changing space-time relationships of external objects (or the internal equivalents of the latter, namely, images, percepts, concepts), when processed by the human brain, are thinking and reasoning. Even the assertion, "I am happy" denotes a certain endocrinological ego-environment homeostasis, an interactional continuing space-time relationship.

These internalized relational elements between image-type concepts are actively utilized in the neural thought processes so that the human organism can postulate trial manipulative "runs" of the image/concept-data without having to deal with or handle the objects themselves. It is not too much to suggest that thinking and reasoning evolved because there was (and is) an immense survival value in the organism being able neurologically to simulate (symbolically and sometimes abstractly) actual or possible or even hypothetical series of interrelated events without the actual events occurring or without the objects themselves being present. A definition of thought in those terms would be the dynamic (neurological) manipulation of internalized models and their interrelationship structures, all of which attempt more or less to simulate reality (e.g. planning a road system or even an abstract painting).

These thinking and reasoning relationship manipulations are the *key* to the nature and structure of all meaningful language as symbol systems. In fact, morphemes, words, phrases, sentences, and—from another angle—syntax are no more or less than auditory or visual *labels* strung together as the communicative *matching equivalents* for pure sensory-originated (in the past) image concepts and their direct interrelationships. The communicative aspect may be internally facilitative, or externally transmitting, or both.

Summarizing the above discussion, one can say that first, thought is the fundamental reason for the existence of language; second, that thought is not language in the "word-sentence" sense of the term; third, that as well as concepts, an essential part of thinking is to be found in the manipulative relational elements between concepts; fourth, that these relational factors have reality in space-time changes; and fifth, that they can exist as internalized dynamic (or passive-observational) models which can be manipulated hypothetically. Most important of all, these relational elements themselves can be symbolized (or represented) on the verbal word level, and moreover these verbal equivalents of space/time relationships only become truly meaningful when they interconnect concepts: for example, a) I can actually *look* at a bush *between* two trees; b) I can pictorial[ly] *imagine* a bush between two trees; [an]d c) I can *say or write* "A bush *between* two trees." If one adds the movement-change relation to the mix, usually in the form of a verb, d) I can say "A bush *is standing between two trees.*" The complete relationship of bush and trees is 1) in the present *time*, 2) standing (paradoxically a static *motion*), and 3) *between*, i.e., spatially in the center. Similar analyses can be made for auditory, kinesthetic/motor, tactile, visceral images, or any other kinds of imagery including mixtures of these. Even abstraction in this context is a psychological image-concept phenomenon, essentially nonverbal in nature, which may sometimes be represented verbally.

Unfortunately, space permits no further elaboration of these aspects of thinking or the parallel symbolization process, language. Much of the above section has stressed the association of image/concept with language symbols, particularly the auditory symbolic system. There is a need to clarify further the association processes between image/concepts, their auditory symbolic system, and the visual symbolic system.

Meaning to sound-label association

One point needs to be made clearly: syntax or the sequence of auditory symbol-labels is almost completely determined by the interrelationship determinants linking purely nonverbal image/concepts. Image/concepts as internalized "things" are action-manipulated in space-time, selectively qualified with intrinsic attributes, and quantified by relative evaluations; and it is the sequence of these factors which determines syntax; e.g.:

The heavy	man	ate	the brown	bread
quantity	thing	action	quality	thing

If one asks why the sequence subject-verb-object (or its linguistic equivalent) occurs, it follows that this is the visual temporal sequence of the event in terms of their cause-and-effect importance to the speaker; e.g., "The heavy man caused to be consumed the brown bread." The continuing conversation is probably centered around the heavy man and his diet. The first "thing" mentioned is usually the most important from the "stage-setting" point of view; e.g., in the sentence, "The brown bread was eaten by the heavy man," the speaker no doubt feels the bread was most important, and the continuing conversation is probably centered around the bread. It is worth noting that habitual thought sequences develop cliché-like habitual word sequences; e.g., "What is for dinner tonight, dear?" These can be automatically processed at speed. However, original or strange thoughts (or when listening, words) may be very hesitantly processed (*4*). The foregoing discussion has elaborated the relationship of syntactical sequencing to meaning sequences. The image/concept to sound-label association has been described earlier in the paper. There remains the auditory-to-visual symbol system association to clarify.

Auditory label-visual label associations

In learning to read, children learn to associate sound-labels with visual-labels (and vice versa) on both a gestalt whole-word basis and on a phoneme-grapheme analytic-synthetic basis. Of course, there will be a bias in keeping with the method used to teach the child to read, but children taught to look-and-say will eventually develop a somewhat crude phoneme analysis and blending attack to use on new or difficult words. Although children taught through phonics analyze most words, there are some words with distinctive visual patterns which they seem to recognize immediately as a gestalt. Most research indicates that a combined method with a slight emphasis on phonics is the most efficient technique for teaching reading. The three quarters of beginners who are verbally competent will rapidly learn to read by any method and taught by any teacher.

However, the least competent quarter of beginner readers, together with the severe reading disability cases, is quite a different educational proposition. Slight differences in teaching techniques or sensory training may bring about startling differences in attainment. The matching of specific remedial methods to specific deficits has been dealt with in another paper (*2*). The associative processes involved in decoding (reading) or encoding (spelling and writing) from the auditory-visual point of view, i.e., taking the 'meaning' for granted, will be briefly outlined. The child has to turn the gestalt of letters into sounds or the gestalt of sound into letters. Most competent adult readers can transfer instantly either way, but the beginner or poor reader who cannot recognize or spell a particular word has to cope with it with an analytic attack of some kind. Content may provide some clues, but often there is insufficient evidence for even a reasonable guess.

Irregular orthography

The phoneme-grapheme matching (orthography) system in English is notoriously irregular in both decoding and encoding. (Here decoding refers to decoding the visual graphemes into auditory phonemes; and encoding, to "translating" the auditory phonemes into visual graphemes. The fact that there are *two stages* or sets of both decoding and encoding in reading and spelling is never mentioned or made clear by most writers.) Because grapheme-phoneme orthography is so irregular, each paired association as it appears in each word has to be learned by rote memory in association with the only distinctive feature of that word, namely, its meaning-in-context. The dog is a *bow*-wow; the knights *bow* to the queen; the archer aims his *bow*; the *bough* is on the tree. The girl ties her hair with a *bow* because her *beau* is coming to meet her.

The phoneme-grapheme rote memory association (within a single "content-meaning") is extremely difficult to establish in most severe reading disability cases. Even more difficult to ingrain is the rapid automatic sequencing of these associations—what reading or spelling is. Investigation of this disability leads to the conclusion that the major problem for most of these children lies in their poor ability to identify auditory-phonemes and in the sequencing (blending) aspects of the phoneme-grapheme association.

Auditory discrimination of phonemes

Usually children do not need to hear the separate phonemes within a word when they hear or speak them in normal conversation. No doubt to some extent the economies of the neurological computer do demand "bit" storage of sounds possibly in two separate places, one for listening and one for speaking. This process is largely automatic, and the sequences of "bits" become to all intents and purposes gestalts of sound which are near enough to their ideal phonetic equivalent. Because many boys with reading disability do not listen accurately, their registration and production of words may be somewhat distorted. In the course of normal conversation, the auditory closure of other people (closure copes with accent variations and the like) who are listening makes appropriate allowances for these mispronunciations so they do not matter. However, in reading and spelling they can be a distinct handicap because the distortion of phonemes creates even more chaos and irregularity with grapheme processing. When spelling, one internally sequences the phonemes and transposes them into graphemes. If a) the phonemes are distorted, b) phoneme-grapheme correspondence is inherently irregular, and c) the phonemes are auditorially unseparated in an outburst of sound, then the grapheme (and hence letter) sequencing output on paper will be equally chaotic. Likewise in reading, even if the poor reader with these three handicaps was able to split up words into purely visual grapheme segments, the decoding of them into their respective sequence of correct phonemes (which would then be blended into gestalts of sound) would be equally chaotic. This process is what happens even though on tests there is nothing wrong with the hearing or mental ability of these children.

Therefore, in those reading disability cases whose vision and motor integration processes are neurologically intact, one should embark on an intensive training program which emphasizes listening to words and identifying phonemes, clear phoneme articulation as in elocution, the correct blending of phonemes in speech, the permutations and combinations of phoneme-grapheme memory associations learned by rote (encoding and decoding), increased auditory closure from the child's own mispronunciations of sounded words, and the identification of ambiguous graphemes/phonemes from the context of the sentence. Furthermore, if these children are taught to spell and write words and then sentences, they will automatically learn to read because the encoding process involves the recall of phoneme-grapheme equivalents automatically without the aid of the visually recognized stimulus of the printed word. However, any visual devices, such as small letter cards or grapheme cards which facilitate correct sequencing, are very much in order.

Concluding remarks

This paper has surveyed the field of language learning in some of its aspects only very sketchily, and much supporting argument and evidence have been necessarily deleted. If a slender case has been made for the importance of auditory factors in reading, it will have served its purpose. Illiteracy is largely the result of legally requiring all children to reach a high level of attainment. If this requirement existed for music, many might be found "musically dyslexic." After all, until recently almost all language was expressed vocally.

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AUDITORY MODALITY AND READING

Auditory Modality, Research and Practice*

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THE PURPOSE OF THIS PAPER is to discuss and attempt to clarify the role of auditory perception, especially the functions of auditory discrimination and auditory memory, in the process of learning to read. These functions, it is held here, are important contributing factors to the success or failure of children in a normal classroom and should be more widely recognized as such.

A complete definition and interpretation of auditory perception and the role it plays in the modality concept of learning are discussed elsewhere in this publication [See Chapter 1]. For present clarification, however, auditory discrimination is the ability to differentiate between closely related speech sounds. Auditory memory is the ability to retain and recall these sounds. An important aspect of this definition should be kept in mind. Auditory discrimination and auditory memory in the present framework are referred to as perceptual qualities and are regarded as a part of the sensory aural input pathway that contributes as a *foundation* for the conceptual level of learning and not to sensation plus meaning as is sometimes found in other contexts.

In linguists' terminology, reading is decoding. It corresponds, in process, to listening. In fact, according to Carroll (*2*), there are two distinct stages specific to the early reading process. The child first learns that the symbols which appear on a printed page represent and correspond to his spoken language. In other words, the initial stage of reading consists of decoding orthography into previously learned speech patterns. The second stage involves comprehension through arousal of associations to effect a meaningful state derived from past verbal learning. The ability to discriminate fine differences in speech sounds and to retain and to recall them facilitates the phonological development in very young children, language acquisition, and articulation accuracy. It follows a rather natural logic that these abilities would aid in the decoding.

Since the early 1930's auditory discrimination and memory abilities have been the subject of much study relative to speech development as well as to reading. In some instances, intercorrelations have been sought between the four factors. Such studies have revealed that auditory perceptual abilities are related to success in beginning reading. It is understood from these studies that 1) there is a consistent increase in sound-discrimination ability with age; 2) children vary in the rate of development of both auditory discrimination and auditory memory; 3) the development of auditory discrimination and auditory memory has not reached fruition in some children until the ninth year; and 4) the auditory measures are not in themselves predictors of success or failure in reading.

Wepman has studied auditory perception and the relation it holds to speech and reading in young children. He has drawn similar conclusions from his studies to the foregoing and has offered a detailed theoretical analysis pertaining to these conclusions (*7, 8, 9, 10, 11, 12*). In addition to those four points, the Wepman focus has been on the significant fact that whether children have a speech defect, those who have inadequate auditory discrimination are the more likely ones within the group to be poor readers. In discussing the implications of his research and the findings of others, Wepman argues that children should

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be studied as they reach school age to determine whether their auditory abilities have developed to the level that phonic instruction is beneficial. Unless this rating is done, Wepman feels that it would be a continuing erroneous practice to approach all children as though they can learn equally well through the same modality. He suggested grouping of children according to modality ability for learning as determined by early assessment. It is somewhat ironic that as long ago as 1935, Bond (*1*) cited evidence from his inquiry into the same area that led him to a similar recommendation.

Even in light of the established features that are now known regarding auditory discrimination and memory and their relationship to reading ability, however, inquiry continues along the same line. It appears that these similar researches are not executed as replications of previous studies but as if further probing might produce insights that would strengthen the already known positive relationships and provide a more definite, less complex solution to the problem for those concerned with the teaching of reading. This type of solution to the problem has not been forthcoming, however, and it seems appropriate to explore the meaning of this statement. This writer feels that auditory discrimination and memory are but one set of factors that may contribute to the success or failure of children in beginning reading instruction. Virtually absent in the literature are longitudinal studies of normal populations and experimental populations which would put into better perspective the overall implications of the role of the auditory measures in beginning reading or in general school achievement.

Longitudinal study

In an effort to address this particular issue a longitudinal study of a normal school population was begun in 1963. The children were initially tested upon entering first grade, at the end of second grade, and again upon completion of third grade. There were 179 children who were present for the entire three-year period. The parameters of the overall study included articulation, intelligence, auditory and visual perception, oral motor movement, visual motor ability, and reading readiness measured upon the completion of kindergarten to be compared with later achievement testing.

The specific tests used were the Wepman Auditory Discrimination Test (*7*), an experimental test for auditory memory using consonant-vowel nonsense syllables, experimental tests for visual memory and discrimination that incorporate the use of geometric forms (*6*), the Lorge-Thorndike Group Intelligence Tests (*3*), and the Metropolitan Readiness and Achievement Tests (*4*) for the appropriate grade levels.

Although the final report of this longitudinal study is as yet forthcoming, we have arrived at some interesting empirical corroboration for the theoretical considerations previously discussed. Table 1, for example, shows the mean differences in auditory perceptual ability between scores at the first- and the third-grade levels. The t test shows that this difference is significant ($p < .01$). The same table also shows the mean differences in visual perceptual ability between scores at the first- and the third-grade levels. These differences are also significant ($p < .01$). Thus, the notion of a developmental progression in perceptual ability is again confirmed in the performances of this population in the first three years of school. It should be noted, too, that the coefficients of correlation of improvement in the auditory modality with improvement in the visual modality are low, a finding which means that children who improve in one modality may or may not improve in the other. In other words, the study has shown that perceptual abilities develop significantly in the first three years of school in a normal population and that these abilities progress individually along lines of modality preference at differing rates in the same individual.

TABLE 1

MEAN DIFFERENCES BETWEEN SCORES AT FIRST AND THIRD GRADE LEVELS

Test	N	Mean Score Difference (improvement)	Standard Error	t
Auditory Discrimination	174	3.483	0.410	8.50*
Auditory Memory	179	-.318	0.076	-4.20*
Visual Discrimination	179	2.430	0.128	18.92*
Visual Memory	179	2.810	0.149	18.19

COEFFICIENTS OF CORRELATION OF DIFFERENCE SCORES OF AUDITORY AND VISUAL PERCEPTUAL ACHIEVEMENT

	Auditory Discrimination	Auditory Memory	Visual Discrimination	Visual Memory
Auditory Discrimination	1.00			
Auditory Memory	-.039	1.00		
Visual Discrimination	.110	-.166	1.00	
Visual Memory	.016	.140	.198	1.00

* Significant at .01 level

Table 2 shows the relationship between auditory perceptual ability at the beginning of first grade and school achievement, as measured by the Metropolitan Achievement Test subtests at the end of the third grade. Auditory perceptual abilities (discrimination and memory) are significantly correlated with every subtest of the achievement battery ($p < .01$). It can be seen then that auditory perceptual difficulties at the beginning of school may contribute somewhat to the level of school achievement for as long as three years. Table 3 shows the relationship of the visual perceptual abilities (discrimination and memory) at the beginning of grade one to the same subtests of the Metropolitan Achievement Test, measured at the end of grade three. Both of these factors are significantly correlated with most of the subtests ($p < .01$). The exceptions are visual memory and the two subtests, Punctuation and Language Total ($p < .05$). Visual memory and language usage have no significant correlation. The effect of early perceptual difficulties on achievement beyond the third grade has not been tested as yet. However, a continuation of the present study is in progress and should clarify this issue.

Conclusions

The findings of the present study support those theoretical considerations of the modality concept of learning to which it was addressed. That perception is a developing process in children into the early school years is not being argued. The emphasis here is twofold. First is the consideration of the effect that this phenomenon of development may have on the child as he enters first grade. Coefficients of correlation, such as the ones presented here that demonstrate significant relationships between first-grade perceptual ability and third-year achieve-

TABLE 2

CORRELATION OF AUDITORY PERCEPTUAL ABILITY (FIRST YEAR) AND SCHOOL ACHIEVEMENT (THIRD YEAR)

	First Grade Scores	
Metropolitan Third Grade Achievement	Auditory Discrimination	Auditory Memory
Word Knowledge	.342**	.216**
Word Discrimination	.273**	.299**
Reading	.225**	.242**
Spelling	.282**	.290**
Language Usage	.242**	.267**
Punctuation	.303**	.278**
Language Total	.306**	.303**
Arithmetic Computation	.286**	.208**
Arithmetic, Problem Solving	.285**	.226**

N = 179
** Significant at .01 level

TABLE 3

OTHER PERCEPTUAL FACTORS CORRELATED WITH SCHOOL ACHIEVEMENT

	First Grade Scores	
Metropolitan Third Grade Achievement	Visual Discrimination	Visual Memory
Word Knowledge	.243**	.242**
Word Discrimination	.236**	.269**
Reading	.243**	.237**
Spelling	.240**	.272**
Language Usage	.202**	.135
Punctuation	.273**	.200*
Language Total	.267**	.192*
Arithmetic, Computation	.231**	.214**
Arithmetic, Problem Solving	.263**	.257**

N = 179
* Significant at .05 level
** Significant at .01 level

ment, cannot be overlooked. The stage of development in the various modalities and the adequacy of this development to support the learning that is necessary in the early grades is of crucial importance to successful [illegible]evement in the early grades.

[illegible]e second consideration concerns specific recommendations which seem appropriate in dealing with all children entering first grade. These recommendations follow the theoretical concepts mentioned earlier that are supported by the empirical findings presented here. In first, second, and third grades in any elementary school, most children learn the three "R's" by whatever methods are utilized. However, in every class will be children who learn more slowly than others. The complexity of the learning process does not allow full discussion here of all of the possible factors characteristic of the slow learner. However, it would appear from the results of the present study that one strong possibility contributing to this condition, one that can be assessed quite readily, is the adequacy of the auditory perceptual ability of first graders. For the purposes of individual maximum potential education, ability grouping on the basis of modality preference as shown by the test results would seem in order.

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The Evaluation of Auditory Abilities in the Appraisal of Children with Reading Problems

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IN HIS BOOK, *Language and Thought,* Carroll (*1*:62) defined reading as

> . . . the activity of reconstructing (overtly or covertly) a reasonable spoken message from a printed text and making meaning responses to the reconstructed message that would parallel those that would be made to the spoken message.

Auditory processes play a major role in the mastery of this "activity." The reconstruction of a spoken message from a printed page involves the transformation of visual stimuli into auditory stimuli. Graphemes are transformed into phonemes; printed words are transformed into spoken words. If a child is unable to receive phonemes clearly, respond to them discretely, retain them in accurate sequences, and organize them into linguistic signs, he is likely to encounter formidable difficulties in learning to read. A careful appraisal of auditory processes and skills, therefore, should be an important feature of the assessment of every child with a reading problem.

In accordance with most of the previous work in the field, the first systematic approaches to the evaluation of the auditory abilities of children with reading problems stressed the appraisal of the various auditory processes that might be involved in learning to read (*2*). Thus, judgments were sought about the following:

Auditory sensitivity, in terms of the demonstrated ability to hear a variety of signals at appropriate levels of loudness.

Auditory attending, including both the ability to select a relevant stimulus from a background of irrelevant stimuli and the ability to maintain attention to relevant stimuli for appropriate lengths of time.

Auditory discrimination, including both the ability to identify the presence of a given sound in a sequence of sounds and the ability to differentiate among similar sounds.

Auditory memory, including the amount of heard information that can be retained and the ability to retain the elements of a series of stimuli in accurate sequence.

Auditory integration, or the ability to synthesize elemental signals into meaningful oral signs.

Auditory-visual integration, or the ability to establish relationships between heard signals and graphic representations of these signals.

Based upon observations of children's responses to tests which presumably assessed these abilities, it was concluded that a child's reading difficulties could be at least partially attributed to poor auditory discrimination, poor auditory memory, and the inability to integrate auditory and visual stimuli. As more experience with this approach to evaluation was gained, however, its merit on at least three counts was questioned:

First, it was virtually impossible to construct tests to assess most auditory processes which were not heavily contaminated with demands on other processes. For example, the popular minimal-pair technique was used to assess discrimination: a child is presented with word pairs (*pin-pen, cope-coke*,) and is asked to report whether the pairs are alike or different. In this test, the demands on auditory memory frequently seem to exceed the difficulty of the required discrimination since the child must retain the first word in exact form so that he can compare it with the second word. It was also observed that many children found the listening to long series of word pairs in a situation devoid of meaningful context to be extremely tedious. In many instances, therefore, the testers seemed to be assessing attending as much as assessing discrimination.

Second, it was observed that several of the tests were difficult for some children who were good readers with good word attack skills, especially in the sound-blending tests that entailed blending phonemes beyond a single syllable. Also many of the tests correlated poorly with the actual level of word-calling skills demonstrated by children with reading problems; sometimes children who showed many difficulties on some of the auditory tests actually performed quite well on a test which required sounding out unfamiliar words.

Third, testers were unable to translate conclusions into answers to the most important question of all, "How should the child's educational program be planned to overcome or compensate for his disabilities?" In responding to this question, some general auditory calisthenics which presumably rehearsed the child in the areas in which he was deficient were usually proposed. Seldom, however, was any direct relationship established between these activities and the actual tasks that would confront the child while learning to reconstruct "a reasonable spoken message from a printed text."

Appraisal of five levels

For the past two years work on another approach has been in process. It is still developing, and most of its components are, as yet, unstandardized. Of the various aspects of auditory function listed earlier, the isolation of only one for assessment, that of auditory sensitivity, is routinely attempted. If sensitivity is reduced, testers proceed to administer the speech discrimination tests conventionally employed in audiology clinics. The remainder of the assessment consists of answering a series of questions established at five different levels. These questions are answered on the basis of observations of a child's ability to perform a series of tasks believed to be directly related to reading.

The five levels were formulated on the assumption that the achievements described at each level are subserved by all the achievements at all of the lower levels. It should be impossible, therefore, for a child to meet the criteria for success at any level unless he were also successful at all preceding levels. In conducting an evaluation, therefore, the highest level (Level V) is considered first. If the child is unsuccessful at this level, each lower level is considered in turn until the criteria for success are met. For example, the highest level relates to a child's ability to call unfamiliar words within the rules of our language system. If he is able to perform it is assumed that all of the auditory skills which he needs to learn to read are adequately developed and that no further assessment of auditory skills is required. Or, if he fails at Level V, evaluation is begun on the skills identified at Level IV: sound blending, syllabication, and phoneme-grapheme interchange. If he succeeds at this level, then it is concluded that the component skills which immediately subserve word calling have been adequately mastered but the child has not as yet learned to integrate them sufficiently to accomplish the word-calling task.

The following are the five levels, tentatively described, listed in the order in which they were appraised.

Level V: Can the child call unfamiliar printed words within the conventions of language; that is, can he translate graphemes into phonemes which might logically be appropriate and integrate these phonemes into words or word-like units?

Level IV: Can the child blend phonemes into syllables and syllables into words? Can he identify syllabic units in heard multisyllabic words? Can he interchange commonly used phonemes and graphemes in syllables made up of vowels and consonants combined in a variety of ways?

Level III: Can the child isolate phonemes within words; that is, can he determine whether a particular phoneme is present? Can he also differentiate between acoustically-similar phonemes?

Level II: Can the child echoically reproduce, accurately in correct sequence, phonemes which are grouped to form unfamiliar words? (Misarticulations associated with structural deviations or with problems in fine motor coordination of the articulators are accepted. On the other hand, marked deviations in phoneme reproduction that are associated with dialects are not accepted. Children often encounter formidable problems in learning to read when they use a dialect that significantly alters or omits many of the phonemes used by most speakers of American English. Virtually all instruction in word attack skills assumes the use of the phoneme system employed by the middle class of the particular region in which the school is located.)

Level I: Can the child echoically reproduce the common phonemes of language? (Again the criteria relating to articulatory deviations noted at *Level II* are applied.)

It is readily apparent that *Levels IV* and *V* involve visual as well as auditory processes. Failures at these levels may be attributable to failures in the mastery of auditory skills, visual skills, or both. It is frequently necessary, therefore, to conduct a similar evaluation of the child's mastery of the visual skills which subserve these two levels.

It is also obvious that different children may show a wide range of achievement within a given level. The investigators are attempting, therefore, to develop a critical sampling procedure to first identify those children who probably have difficulties at a given level. When such difficulties are discovered, more exhaustive evaluations are conducted to identify the specific tasks that are difficult for each child. At *Level III*, for example, a particular child may make all vowel discriminations except for the short *e*—short *i* discrimination, make all discriminations between voiced and voiceless consonants, but be unable to discriminate consistently between *p* and *k*, *p* and *t*, and *f* and the voiceless *th*, particularly when these phonemes occur at the ends of words. In this instance, one would not simply conclude, "This child has an auditory discrimination problem" but would rather specify the phonemes that the child confuses. Or, in other instances, where discrimination is intact, but problems are evident at *Level IV*, one might conclude that sound-blending problems seem to be more evident when specific phoneme combinations are presented, for example, when two or more consonants occur together. Perhaps one might also observe that particular combinations of phonemes make syllable identification particularly difficult. For example, a child might have particular difficulty in identifying a syllable when it begins with the same consonant that is at the end of the previous syllable or when one syllable ends with a vowel and the next syllable begins with a vowel. One might also observe that a child has difficulties with specific grapheme-phoneme interchanges; for example, he may omit one consonant from consonant blends.

The widespread emphasis on the identification of specific deficits in auditory processes has fostered the assumption that these deficits are usually manifestations of aberrations or dysfunctions of organic systems. Although organic impairments may occasionally be present, most of the children seen demonstrate problems that result primarily from failures in the learning of auditory skills. Most formal instruction in word attack skills begins with the assumption that a child can function successfully at *Levels I, II*, and *III;* thus instruction begins with teaching phoneme-grapheme interchange. The word attack problems of many older children are characterized by profound confusions complicated by the application of ill-assimilated rule fragments. Many of these confusions begin when children are confronted with *Level IV* activities before they have mastered the skills which subserve these activities.

In describing this current approach to the evaluation of the auditory abilities of children with reading problems, one does not mean to disparage more basic studies of auditory processes and skills. Many important questions that relate directly to reading will remain unanswered until more is learned from these studies. An excellent illustration of the need for these more basic studies is evident in the major shortcomings in the evaluative approach described. Although the approach assesses a child's achievement level in the hierarchy of reading-related auditory skills, it provides relatively little information about appropriate strategies in assisting him to learn the skills that are next in sequence. Presumably, particular strategies may be more effective than others, depending upon a child's particular strengths and weaknesses in auditory processes.

Summary

Many of the tasks that must be mastered before a child can read successfully rely heavily upon auditory processes. Thorough assessment of auditory processes and skills is, therefore, an essential component of the evaluation of children with reading problems. Currently, assessment of these skills through direct observations of children's levels of achievement in a hierarchy of tasks that relate directly to reading is being approached. Conclusions that emerge regarding a child's abilities and disabilities can be more directly applied in educational planning than can the results of more traditional approaches to the evaluation of auditory processes.

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VISUAL MODALITY AND READING

Visual Modality, Research and Practice

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IT IS TEMPTING to look for a single cause for any deficit in a child's performance. Reading difficulties are often thought of as being due to a single exogenous cause, such as emotional disturbance or brain injury, or to a single underlying symptom, such as poor visual skills, auditory perceptual defects, lack of body awareness, or poor teaching. There is only one way to conceptualize a single underlying cause as being at the root of reading difficulties, and that is to use the "umbrella" concept of "disturbed brain functions."

Cohn (*11*) reported a study of 46 children, seven to ten years of age, who had been diagnosed as showing "specific reading and writing difficulties." He concluded that difficulty in using graphic symbols for communication purposes is an expression of a disturbance of brain function, which often affects a variety of other abilities, such as language ability, position sense, and time perception. Cohn is only one of many to use the concept of brain dysfunction for an explanation of the multiple symptomatology characteristically found in reading difficulties. This concept is parsimonious, but care must be taken not to infer the use of the term as a contrast to emotional disturbance. The term is certainly valid as long as it is understood that brain dysfunction might be an expression of neurological disturbance, emotional disturbance, maturational lag, familial defects, cultural deprivation, or physical illness. This formulation, however, gives no indication for treatment. For treatment purposes, it is profitable to pursue a diagnosis of the symptoms of the "brain dysfunction" which directly contribute to the reading disability.

Symptoms of reading disabilities

The symptoms associated with reading difficulties are multitudinal because many skills are involved in reading. A deficit in any of these skills may influence the reading process adversely. For example, in learning to read a child needs such sensory-motor skills as eye-movement control for scanning the pages and finger control for turning them. He also needs various auditory and visual perceptual skills, language skills, and the ability to think logically, draw conclusions, and make inferences.

Training directed solely toward advancing the best developed skills often gives spuriously good results. Hagin (*44*) reported the case of a child with severe visual perceptual difficulties who had not learned to read at all. With the use of i.t.a., in one year he progressed to a seventh grade level in word reading. Unfortunately, his reading comprehension did not improve. Hagin concluded that optimum improvement can only be insured if teaching methods are used which improve the most deficient abilities.

The Center* advocates a policy of using specific training methods to develop lagging skills. It is important to use the child's best developed abilities and his best modality for the learning of new subject matter and skills, as has been suggested by Wepman (Chapter 1). Every effort should be made to ameliorate what Gallagher (*25*) calls "developmental imbalance."

Disabilities in visual perception

Research has shown that one of the most frequent expressions of brain

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dysfunction is a deficit in visual perception and that deficits in visual perception are common in children with reading difficulties. They are rarely the only cause of reading failure, but they seem to be one of the most important contributing factors. Graubard (*27*) found that deficits in the visual-motor channel occurred more frequently than deficits in the auditory channel; and Weintraub's (*55*) review of the research showed that visual perceptual deficits had more bearing than auditory perceptual deficits on difficulties in reading up to the third grade level.

Center experience indicates that visual perceptual difficulties occur often in cases of learning difficulties, even at an older age. For instance, in a sample of 89 children, nine or older, referred to the Center because of learning difficulties, 78 percent had visual perceptual inadequacy. In other children above nine, where visual perceptual difficulties could not be certainly ascertained, their presence was implied in the reports of early difficulties with sensory-motor tasks.

Visual perceptual disabilities affect beginning reading. In a cooperative research project (*33*) with the University Elementary School, University of California, Los Angeles, a group of 25 children between the ages of 4½ and 6½ were exposed to reading material but not forced or pressured to use it. The Frostig Test was given to these children in July 1962; eight had perceptual quotients in the lowest quartile (90 or below). In October 1962, it was found that none of the children with a PQ below 90 had begun to read; of the two children with a PQ of 90, one had learned to read very well; the other had not. Only one of the children with a PQ above 90 showed reading difficulties.

In the more usual classroom situations where all children are expected and required to learn to read, the coefficient of correlation between visual perceptual skills and beginning reading ability has been found to be between .4 and .5 (*26*), (*34*),* (*45*). But the pressure which is needed to "make" these children read and the difficulties which many of them have in acquiring other basic skills, such as arithmetic and writing, may result in emotional disturbances. The foregoing was indicated by the finding that among the kindergarten and first grade children rated by their teachers as most poorly adjusted in the classroom, the vast majority were those with PQ's below 90. (The chi square values were significant at the .001 level.)

Perception is here defined as the discrimination and recognition of stimuli impinging on the senses. In the literature, however, the term is used in a variety of ways, sometimes synonymously with sensory-motor function. Bower (*9*) pointed out that the response to a stimulus can be either a motor or a perceptual one, and he proved that perceptual abilities are present in infants before any controlled motor patterns have developed. A distinction between the two terms should be emphasized. The reasons are heuristic as well as epistomological because the dichotomy leads to a clearer delineation of training and treatment procedures.

Nevertheless, the development of perceptual abilities and the development of motor abilities are closely interconnected. This paper, therefore, includes a discussion of deviations in perceptual-motor development as possible contributors to reading failure. For example, visual efficiency and ocular-motor skills are mentioned in the literature as contributing to reading success. Optometrists have been most concerned with the efficiency of the eye as opposed to the efficiency of brain function in reading. Their claims concerning the importance of intact and accurate visual accuity for reading ability have been disputed (*6*). Claims and counterclaims have also been made in regard to ocular-muscular

*By third grade, however, the correlation between visual perceptual skills and reading ability in the average public school classroom is nonsignificant (*10*).

skills. Prechtl (*40*), for instance, states that it is common sense that erratic eye movements must retard reading ability, while Jones and others (*30*), in an eye-tracking experiment, found that the ability of subjects to fixate and follow stripes on a slowly revolving drum did not correlate with lower or higher reading readiness. Although opinions are divided on the issue of the effects of erratic eye movements, eye tracking exercises are included in the Center program, first, because clinical observation indicates the correctness of Prechtl's point of view and, second, because educational procedures to which helpfulness has been widely ascribed and which are certainly not damaging or time-consuming should be disproved before they are discarded.

Laterality

The question of laterality is also raised here because it is another prominent issue about which opinions are sharply divided. Silver and Hagin (*43*) believe that disturbances of laterality are nearly universal in children with reading difficulties. Graubard (*27*) also found many cases of cross dominance or unestablished laterality among poor readers.

Other researchers disagree. Flick (*18*), for example, states that eye-hand dominance does not seem to be related to reading difficulties. Eisenson (*14*) writes:

> Some authorities feel that aphasic children may demonstrate varying degrees of confused laterality. They consider this lack of cerebral dominance to be a causative factor or aphasia. However, there is as yet little evidence to support this latter contention.

(Specific reading difficulty is usually considered a form of aphasia by authors who use this term.) Ayers (*1*) found no likelihood of a relationship between laterality functions and those clinical syndromes she studied focusing on the sensory modalities of touch proprioception and vision. She considered eye and hand dominance to be unrelated to perceptual-motor functions in general. It is the writer's understanding that Ayres differentiates between laterality and hemispheric integration. Her position results in the institution of training which promotes simultaneous movement of the right and left side of the body or body parts: the training does not, however, focus on the establishment of dominance but of hemispheric integration (*2*).

In summary, while some workers support Orton's belief (*38*) that disturbances in laterality may be causative in the case of reading difficulties, the majority now seem to be of the opinion that it is only the effect of unestablished laterality on left-right orientation which constitutes a handicap. Left-right orientation is basic to smooth reading because the acts of reading and writing involve a progression from left to right. Center research supports the majority of studies in indicating that eye and foot dominance and cross laterality are of no consequence to any other developmental functions and, therefore, most probably not to reading.

Motor dysfunctions and reading

It has sometimes been assumed that reading disturbances are highly correlated with motor disturbances and that there may be a common cause. Ayres (*1*) does not believe that reading should be delayed until the child's motor abilities have improved. A concomitant program might assist the child's ability to learn to read. This contention has been supported in a sample of children with learning disturbances, in which many children were well coordinated, while others showed general clumsiness. Sprainga (*46*) also reported that 29 percent of a sample of 45 children with severe reading difficulties showed a delay in motor development.

It is believed that specific physical education should be instituted in cases of nonestablished laterality, directionality, and general motor incoordination, regardless of the existence of reading difficulties. Kephart (*32*), Barsch (*5*), and Ayres have contributed most significantly to the foregoing idea.

It is also believed that to delay the institution of other remedial training and of beginning reading until motor disabilities have been overcome is a dangerous practice indeed. Motor training can be effectively integrated with a full remedial program except in some severely neurologically handicapped children.

Effects of specific visual perceptual disturbances

Various research workers, including Piaget (*39*), Cruickshank (*13*), Wedell (*54*), and Thurstone (*50*), have observed that several visual perceptual abilities are involved in the process of recognizing and discriminating stimuli. The Marianne Frostig Developmental Test of Visual Perception (1964) was devised to isolate and evaluate five of these abilities so that training programs could be appropriately applied. The five subtests involve abilities that are of significance for the process of learning: eye-hand coordination, figure-ground perception, constancy of perception, perception of position in space, and perception of spatial relationships.

In the subtest for eye-motor coordination, the child is required to draw lines between guide lines or toward a target. The subtest for figure-ground perception evaluates the ability to perceive certain parts of the visual field as distinct from background features. The child is asked to trace intersecting figures and overlapping figures without being confused by intervening lines. The third subtest evaluates form constancy, which is the ability to recognize shapes, regardless of their patterning, color, size, background, or position in space. The child is required to outline only squares and circles on pages containing other shapes. In the subtest for perception of position in space, the child differentiates between a stimulus figure and identical figures that are reversed or rotated. The foregoing evaluates the ability to perceive the direction of an object in relation to the observer. The final subtest evaluates the perception of spatial relationships or the ability to perceive points or shapes in relation to each other as well as in relation to the observer. In this subtest the child copies a figure by drawing lines between dots.

The various difficulties in reading that occur as a result of disabilities in each of these visual perceptual areas will be briefly discussed. Eye-motor coordination will be omitted, however, as that has already been treated, although cursorily, in the references to sensory-motor functions in general. Many remedial techniques for each visual perceptual area can be found in the teacher's guide and worksheets to the basic "Frostig Program for the Development of Visual Perception," and in the teacher's guides and workbooks of the beginning, intermediate, and advanced "Pictures and Patterns." These include both work with three-dimensional objects and two-dimensional pencil and paper exercises.

Suggestions for instruction

Figure-ground perception is referred to as perceptual decentration by Piaget and his followers. Elkind and other (*15*) found that two decentration tasks—namely, reversing figure and ground and finding hidden figures—were more difficult for slow readers than for normal readers.

Our clinical observations indicate that children with disabilities in figure-ground perception often have difficulty in scanning and in finding their place on the page. They tend to skip words and lines and leave out or substitute letters in words and have difficulty in locating specific information in reference books, such as dictionaries or telephone directories. Cruickshank *et al* (*13*) are among those researchers who have shown that difficulty in figure-ground perception (or decentration, in Piaget's terminology) also has an indirect influence on reading skills. A child with this disability cannot focus on the words in the correct order because his attention jumps from stimulus to stimulus. Alternatively he may get "stuck" on a certain word because he cannot separate himself from the stimulus at will. Reading methods designed to help the child who has a disturbance of figure-ground perception include the use of an L-shaped marker which is pushed slowly along so that the horizontal arm underlines the word that the child should be reading. When the disturbance is severe, it may be necessary to use "a window" through which one word at a time is exposed. A helpful training technique is to have the child attempt to decipher words that intersect. Exercises can also be given in finding certain words, letters, or answers in a page; in crossing out letters while following a line from left to right; and in consulting reference books.

Many researchers, such as Benton (*8*) and Monroe (*35*), have acknowledged the disturbing influence of inaccurate form perception, especially upon younger readers. A child who has difficulty in form perception has difficulty in differentiating among such similar letters as *r*, *n*, and *h*; *v* and *w*; *n* and *m*. He also has difficulty with words of similar configuration, such as, *hay* and *boy*.

Several techniques have been found to be helpful. For example, a child with this difficulty can differentiate between a *d* and an *a* if he is shown that *d* is made up of a circle and a *long* "stick" while *a* consists of a circle and a *short* "stick." The perception will be better established if the child cuts out circles and "sticks" from construction paper and assembles the letters while naming them.

A child with difficulties in form constancy may also learn to read a word in a certain script of print but may fail to recognize the word when it is presented in a different script, type, or context or begins with a capital letter. He may not recognize it when he sees it on a different plane; for example, if he sees it on a vertical chalkboard, when he has learned it in a book. Many children with difficulties in form constancy puzzle their teachers by apparently learning well at first but failing when a new reader is introduced. Because the learning is not transferred from one context to another the child may have forgotten what he apparently knew well.

One remedial technique is to present three or four words written and printed in many different styles on a sheet of paper. Words should be used in different contexts, and children should be exposed to different kinds of print.

Difficulties in recognizing position in space are much more readily recognized than difficulties in perceptual constancy and have often been explored, especially since the publications of Orton (*38*). All young children reverse certain letters, numbers, and words: *b* being read or written as *d*; *p*, as *q*; *6*, as *9*; and *saw*, as *was*. Children with difficulty in perception of position in space may continue to produce these "static reversals." Since directional errors occur frequently in children who have difficulties in right and left discrimination, one of the remedial measures lies in pointing out to the child throughout the school day the direction in which objects about him are facing or their position in relation to himself. A tic-tac-toe type of game can also be played in which the child is told to mark designed squares.

Reversals in writing can be avoided if the letters are practised in grids in which the starting points for the letters are marked. The lines of the grid, which the children know they must not cross, prevent forming the letters wrong. Correct examples of letters should always be on display.

Perception of spatial relationships is required for perceiving patterns. If a child copies dot patterns or uses a picture as a model for stringing beads, he must be able to perceive correctly the spatial relation of each part of the pattern to another as well as its position in relation to his hand and the pencil or string. The perception of spatial relations is similar to figure-ground perception in that both involve perception of parts of the visual field in relation to each other. It differs in that in figure-ground perception the visual field is divided into two unequal parts: a prominent figure and an unobtrusive ground; in the perception of spatial relationships many parts are perceived in relation to each other, and all receive equal perceptual attention. The result is the correct perception of the total pattern. Thus, when a word is perceived, the letters are "strung" in the right order, in the same way as the beads are strung on a string. The ability to string beads has, in fact, been found to be a fair predictor of reading (*37*).

If a child has difficulty in the perception of spatial relationships, he may scramble letters in words (writing *h s i s p* for *ships*, for instance), and he may scramble the order of words in a similar way. Such "kinetic reversals" obviously cause difficulty in reading and spelling. The child will also be handicapped in such tasks as reading maps, graphs, diagrams of all kinds, and the clock face. Training procedures particularly focused on the reading process include the reproduction of words with dominoes or with link or other letters after they have been exposed either tachistoscopically or for longer periods of time. Other approaches include analyzing and synthesizing words in spelling, using color cues to set off one sound from another—thus accentuating details—and putting scrambled sentences in the right order.

In the foregoing, the role of visual perception has been mentioned, together with that of sensory-motor functions which are related to the perceptual processes. Reading, however, requires additional abilities, one being auditory perception. Reading methods which have a bearing on the ability to integrate the two sense modalities of vision and hearing follow.

Procedures often used for children with associational difficulties are known as V-A-K (visual, auditory, kinesthetic) methods when writing is used. When tracing is added, they are known as the V-A-K-T approach. Fernald's method (*17*) is an example.) One of the disadvantages of V-A-K and V-A-K-T methods is that they are not effective with children who have difficulties in fine visual motor coordination and for whom writing is a very laborious task. As with any other procedure, these are not of help to all children.

Integrating stimuli from three or four sense modalities when the organism has difficulty even with the integration of two is sometimes questioned. Information theory has stated and experiments with perception have shown that simultaneously received stimuli from multiple channels may lead to an overloading and disruption of the orderly electrical activity of the nervous system. It is logical on this basis to reject the use of multisensory approaches; yet these approaches have been effective in the classroom with many children.

The answer to this contradiction lies in the neurophysiological findings of Teuber (*49*) and Semmes (*42*). In observing the defects of war veterans who had suffered head wounds, Semmes reached the following conclusions:

> The centers in the brain concerned with language (oral language) seem to be localized in specific focal areas. The understanding of language depends on the convergence of like elements; that is, it depends upon familiar stimuli stimulating these specific areas. On the other hand, the parts of the brain concerned with spatial functions show a diffuse localization.

Semmes suggested therefore, that spatial functions might depend upon "the convergence of *unlike* elements, with visual, kinesthetic, vestibular, and auditory stimuli combining to create a single supra-modal space." In support of this theory, all of these cues are needed in spatial orientation. In spoken language, by contrast, the fine control of the articulatory apparatus may provide an optimal substrate for speech representation. Such control requires only integration of similar functional units into the brain, and it may be disturbed by input involving a different sense modality. Cues from the vestibular apparatus or kinesthetic cues from other parts of the body are not needed to produce or listen to speech. These findings probably explain the reason that speech therapists working with articulation usually concentrate on the movement involved in speech and exclude other stimuli, whereas educators who attempt to teach visual perceptual skills or who teach children with visual perceptual deficits favor multisensory training methods.

One more function relating to visual perception needs to be discussed because of its great importance for reading—memory for visual sequences. Some children can perceive accurately, both auditorally and visually; they can even associate the auditory and the visual stimulus; yet they do not retain the words they have learned or cannot spell them because they are unable to remember a sequence of letters.

Sample findings agree with literature which indicates that memory for visual sequences is much more often disturbed than memory for auditory sequences. Memory for visual sequences is tested at the center with the visual-motor sequencing subtest of the Illinois Test for Psycholinguistic Abilities, which requires the child to remember a sequence of geometric forms or pictures. The teacher can make picture dominoes or cardboard chips showing letters or words with which children with difficulties in memory for visual sequencing can practice reproducing words and sentences that they have seen.

It should finally be emphasized that children with difficulty in remembering either auditory or visual sequences need much overlearning. In Bannatyne's words (*4*)

> The teacher should not rest until the child's sequencing memory operates on an *automatic* basis.

Summary

Causation and symptomatology in reading difficulties are usually multiple. Treatment should be concerned w[ith a]melioration of the underlying d[eficits] while the child's best abilities for learning new academic skills and subject matter are used.

The frequency of visual perceptual disturbances and their relationships to difficulties in beginning reading and emotional adjustment warrant special attention to these deficits. The latest research shows that perceptual abilities do not originate in motor abilities; nevertheless, certain aspects of motor development influence reading skills directly and are, therefore, of concern to the reading teacher. Of special significance are ocular-motor functions, laterality, and general motor coordination.

Various visual perceptual disabilities may cause specific mistakes in reading. Other factors which may contribute to reading difficulties are poor association between visual and auditory input and poor memory for visual sequences. These may, therefore, require special treatment. It is significant for treatment that Bannatyne (*3*) and Semmes (*42*) concluded that spatial perception involves the integration of visual, kinesthetic, vestibular, and auditory stimuli.

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Perception, Readiness, and Reading Achievement in First Grade

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GENERAL AGREEMENT prevails concerning the significance of individual differences in the process of learning to read. It is often assumed that combinations of these differences and their interaction with both school environment and reading-task demands are in some way crucial to the problems of beginning readers. While many factors related to reading readiness are discussed by reading authorities, precise data concerning the dimensions within these areas (language, intelligence, sensory-perceptual, health) are in the formative stages of acquisition.

The task of the first grade teacher is formidable in the relative absence of operationally defined and measurable capabilities prerequisite to success in reading. Intrinsic characteristics related to the consistent findings of sex differences in early reading achievement also remain a problem with which the teacher must somehow cope. Visual perception has been implicated as a factor of some importance in readiness for reading. The Thurstones (*20*) have shown that there are several abilities in this domain which appear to be far more relevant to reading achievement than the sensory processes initiating them.

Review of the research

In recent years an accumulation of research in the area of visual perception and reading has become available. Differences between studies pertaining to definitions of perception (*1*), criterion-space, predictor space, as well as the populations from which samples are drawn, tend to limit the comparability of these findings. While several early studies (*9, 10, 6, 11, 22*), report low coefficients of correlation between various measures of nonverbal visual perceptual abilities, more recent studies report evidence somewhat to the contrary (*4, 18, 16, 12, 14, 7, 20, 3, 2, 17*). The majority of these latter studies employed samples of first grade children. Perceptual measures involved such factors as visual discrimination, visual-motor coordination, and visual discrimination and perceptual gestalt.

Of special interest is the study by Goins (*12*) in which 14 perceptual measures were administered to two first grade populations. The investigator identified a general factor of visual perception related to first grade reading achievement and defined as strength of closure. Barrett (*2*) reported that three of nine readiness factors made strong contributions in predicting first grade reading achievement. One of these factors, pattern copying, appeared to support the previous findings of Goins. Frostig (*8*) described a perceptual instrument which is relatively easy to administer and which is purported to be useful as a predictive and diagnostic measure in reading achievement and clinical work, respectively. Bryan (*3*) found that the Developmental Test of Visual Perception (DTVP) appeared to be a valuable predictor of both reading readiness and reading achievement for subjects in kindergarten and Grades 1 and 2. Rosen (*17*) found in a first grade population that the perceptual quotient obtained from the DTVP was as significant a predictor of reading criterion measures as the total scores obtained from the Metropolitan Readiness Tests (Form R). Corah and Powell (*5*) factor-analyzed the DTVP battery, two other perceptual measures (Ghent Overlapping Figures and a measure of form constancy) and the Full Range Picture Vocabulary Test. Their findings suggested that two factors accounted for the total variance: general intelligence and developmental changes in perception. The results of the foregoing study are questionable because of the extremely small sample employed ($N = 40$). Further research exploring the factor structure of the Frostig instrument and other readiness measures are indicated.

The research design

The purpose of the present study was to explore the structure of the Frostig Developmental Test of Visual Perception, the Metropolitan Reading Readiness Test, and the New Developmental Reading Tests. In addition, two measures of social class and one of IQ were also included.

The following instruments were used in the study: Metropolitan Reading Readiness Tests (MRRT), Form R; Marianne Frostig Developmental Tests of Visual Perception (DTVP), Third Edition, 1961; Bond-Balow-Hoyt New Developmental Reading Tests (NDRT) Lower Primary Level, Form I; Lorge-Thorndike Intelligence Test (LTIT), Level I, Form I; and Minnesota Scale for Paternal Occupations (MSPO).

All first grade pupils enrolled in the 74 Minneapolis public elementary schools during the academic year 1964-1965 constituted the population for this investigation. A stratified random sample consisting of 25 first grade classrooms of 703 pupils from eight schools was supplied by the research division of the public school system. Complete data were obtained for 637 pupils constituting 90.6 percent of the initial sample. Of these, 324 were boys and 313 girls. The socioeconomic representation of the sample (based upon Minnesota Scale for Paternal Occupations and the school district's socioeconomic scaling) consisted of a typical breakdown for a large urban-metropolitan area.

The Metropolitan Reading Readiness Tests (MRRT) were administered by classroom teachers in the second and third weeks of the school year. One of the investigators administered the DTVP to all children during the last two weeks of September and first week of October and again during the last week of November and first two weeks of December. The Lorge-Thorndike Intelligence Test (LTIT) was administered by one of the investigators to all children during February 1965.

The New Developmental Reading Tests (NDRT) were administered during a three-day period at the end of March by the 25 classroom teachers in the study.

Separate analyses were made for each sex group. The scores for the 23 variables were correlated, and the resulting matrices subjected to a principal components analysis employing unities in the main diagonal. Components whose latent roots were 1.00 or larger were retained and rotated to the varimax criterion following the suggestion of Kaiser (*15*). Prior to interpretation, the factor structures for the male and female subjects were compared by calculating factor congruency coefficients employing procedures presented by Harman (*13*).

Findings and discussion

Inspection of the table of means and standard deviations disclosed that the male and female groups were very similar in IQ, social class, readiness, and perceptual measures considered here. However, the female subjects displayed superior average reading achievement. Tables 1 and 2 present the rotated factor loadings for male and female subjects, respectively, whereas Table 3 presents the factor congruency coefficients.

There are no tests of the statistical significance of coefficients of factor congruence. In general, coefficients greater than .90 are high; .80 to .89, good; .70 to .79, fair; and less than .70, poor. On this basis, four factors across the male and female analyses demonstrate high congruence, and one demonstrated fair congruency. On the other hand, one factor appears to be specific to each analysis. The factors which are highly congruent will be discussed first. For convenience, the male factor enumerators will be employed for identification.

Factor II is clearly a reading achievement factor with the three subtests of the NDRT saturating the factor. The numbers subtest of MRRT has a moderate loading on this factor indicating that the numbers subtest is a predictor of reading achievement. Factor II of the female solution is highly congruent with this male factor (coefficient-.95). The only noteworthy discrepancy is the appearance of a Visual Motor I and II doublet for the male factor (loadings of .32 and .36 respectively) indicating slightly more power in the prediction of reading achievement for this aspect of perception when male subjects are compared with female subjects.

Factor IV for the male subjects is a good match with Factor I in the female analysis. Inspection of the loading pattern suggests that this factor might be called a perceptual readiness factor. Perceptual Constancy I and II, Position Space I and II, and Spatial Relations I and II have major loadings on this factor. Matching, Numbers, and Copying also have substantial loadings on the factor. It is of some interest to note a slight tendency for the reading subtests to load on this factor for females but not for males. The loadings are, however, quite small (.38, .29, and .29 for Word Recognition, Comprehension of Significant Ideas, and Comprehension of Specific Instructions, respectively).

For the male subjects, Factor V is doublet marked by Figure Ground I and II with substantially smaller loadings for Perceptual Constancy I and II. This factor is highly congruent with Factor III for females, the only difference being somewhat higher loadings for Perceptual Constancy I and II for females. It should be noted that this factor is clearly distinguishable

TABLE 1

ROTATED FACTOR LOADING FOR MALES

(N = 324)

VARIABLE	Factor I	II	III	IV	V	VI	h^2
Chronological Age	71	–09	–02	12	08	19	57
IQ	–55	26	25	29	04	21	56
SE (MPS)	–01	–08	–76	–15	00	–19	64
SE (School)	15	–22	–77	05	–01	–14	69
Word Meaning	18	07	16	28	08	75	70
Sentences	–10	18	10	19	11	68	56
Information	03	20	13	26	04	74	68
Matching	09	31	10	59	00	36	59
Numbers	10	47	10	44	04	44	63
Copying	23	30	07	64	01	24	62
Visual Motor I	40	32	29	42	12	–04	54
Figure Ground I	25	18	02	20	66	14	59
Perceptual Constancy I	–23	–03	08	62	26	10	53
Position Space I	–02	34	00	55	–09	18	46
Spatial Relations I	13	29	09	68	03	20	61
Visual Motor II	26	36	39	37	00	–01	48
Figure Ground II	–05	09	–02	07	82	04	69
Perceptual Constancy II	–09	–12	21	63	37	12	61
Position Space II	–05	06	–06	67	08	23	51
Spatial Relations II	12	21	06	67	10	15	54
Word Recognition	–08	81	15	25	11	19	80
Comprehension (Sig. Ideas)	–05	85	16	12	12	11	79
Comprehension (Spec. Instruct.)	–12	85	11	18	09	20	83
Hyperplane Count 0 ± .15	15	7	15	5	19	8	
% Total Variance	5.9	14.1	7.3	18.1	6.2	10.3	

from other perceptual and/or readiness measures as well as reading achievement as measured here.

Factor VI appears to be a specific readiness factor defined by MRRT subtests Word Meaning, Sentences, and Information. A congruency coefficient of .97 when this factor is juxtoposed with Factor V for females indicates a good match. Apparently a substantial portion of the variance of the MRRT is relatively specific to the MRRT and is essentially independent of both perception as measured by the DTVP and reading achievement.

Factor III displays low congruence with female Factor IV. It is clearly marked as a social class factor since the two social class variables in the analysis have their major loadings on this factor for both males and females. The relatively low congruency, due to a substantial negative loading (-.67) of chronological age for females, is not produced in the male analysis. Furthermore, Visual Motor I and II

TABLE 2

ROTATED FACTOR LOADINGS FOR FEMALES

(N = 313)

VARIABLE	Factor I	II	III	IV	V	VI	h^2
Chronological Age	–05	04	12	–67	40	08	64
IQ	44	17	00	41	27	14	48
SE (MPS)	–06	–17	–06	–70	–31	–13	64
SE (School)	09	–43	–15	–55	–26	–16	61
Word Meaning	36	11	08	13	73	04	70
Sentences	30	14	11	02	72	10	65
Information	44	12	19	10	64	08	67
Matching	74	23	–04	03	31	12	72
Numbers	56	44	08	03	37	14	68
Copying	72	19	16	01	18	20	65
Visual Motor I	27	13	02	02	05	78	70
Figure Ground I	11	11	48	–14	22	43	51
Perceptual Constancy I	44	16	49	14	16	–10	52
Position Space I	72	18	04	00	19	13	60
Spatial Relations I	72	25	06	03	18	26	68
Visual Motor II	23	14	15	20	07	65	56
Figure Ground II	–08	08	78	–07	12	21	68
Perceptual Constancy II	50	06	60	25	–04	–09	69
Position Space II	73	11	07	06	14	04	57
Spatial Relations II	75	20	13	04	14	26	71
Word Recognition	38	82	07	13	14	11	87
Comprehension (Sig. Ideas)	29	88	09	10	04	10	88
Comprehension (Spec. Instruct.)	29	84	13	13	16	16	88
Hyperplane Count 0 ± .15	5	10	17	17	8	15	
% Total Variance	21.9	12.9	7.2	7.1	10.3	7.1	

TABLE 3

MATRIX OF FACTOR CONGRUENCE COEFFICIENTS

Factor (Females)	Factor (Males) I	II	III	IV	V	VI
I	07	63	32	**96**	24	69
II	–04	**95**	51	51	28	50
III	05	26	27	52	**92**	36
IV	–54	32	**79**	26	01	25
V	18	46	49	58	31	**97**
VI	44	59	53	53	39	30

are slightly related to the factor for males. The foregoing suggests that Visual Motor ability is partly a function of age for the males of the present sample but not for females.

Female Factor VI is essentially a doublet representing Visual Motor I and II. The identification of such a factor for females is in contrast with the pattern for males where the variance of Visual Motor I and II is distributed across three or four factors. Thus, the Visual Motor task has a complexity of one for females and essentially three or four for males. The last factor to be presented is Male Factor I which is marked by chronological age (.71) and IQ (-.55). Outside of a moderate loading for Visual Motor I (.40), this factor is of little interest in terms of the purposes of this study, except that it serves to indicate that male IQ tended to be inversely related to chronological age.

Summary

In summary, matrices of like sex correlations among subtests of the MRRT, NDRT, two administrations of the DTVP, and measures of IQ and social class were factored separately and rotated to the varimax criterion. In each case, six factors were retained for rotation, employing the criterion of retaining components whose latent root exceeds unity. Comparison of the factor structures for males and females showed a high degree of congruency for four of the six rotated factors. The four highly congruent factors are general reading achievement, perceptual readiness, figure ground perception, and specific readiness. The loading pattern suggests a relatively high degree of independence for these factors with an indication that specific subtests of the DTVP and MRRT make limited contributions to the prediction of reading achievement. There was, however, a slight tendency for a portion of the reading achievement variance for females to load on the perceptual readiness factor, whereas for males, the Visual Motor subtest of the VTVP loaded somewhat on the general reading achievement factor.

The appearance of a unique Figure Ground factor for both females and males is in contrast with the findings of Goins (*12*), Stuart (*18*), and Barrett (*2*), all of whom found that measures of Thurstone's flexibility of closure factor yielded a contribution to the prediction of reading achievement. Apparently, the Figure Ground Test of the DTVP does not measure the perceptual construct of flexibility of closure adequately. This instance may be a premature labeling of a measure in terms of its face validity. The data presented here suggest a lack of construct validity.

A final word might be added concerning the limitations of the present study based upon the assumption that factor analytic methods can lead to insights concerning the organization of reading achievement and the abilities needed to read. It is often asserted that reading ability can be conceptualized as an hierarchically organized set of skills. If so, an adequate exploration of the role of perceptual and readiness factors in the acquisition of such skills obviously requires assessment of proficiency in these skills not at one point in time but rather throughout the instructional sequence. It would then be possible to identify the readiness or perceptual abilities which are required so that the learner could cope with the demands of tasks reflecting the presumed subskills. In other words, one will ask the question, "What perceptual or readiness factors transfer at various points in the sequence of events leading to learning to read well?" Suffice it to say, the utilization of global reading achievement tests, such as those employed here, begs the question. The transfer question as posed is surely one of the questions whose resolution would lead to a more adequate understanding of the process of learning to read.

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Color Cues as an Aid to Good and Poor Readers' Paired-Associate Learning*

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IN A STUDY OF COLOR as an aid to visual perception, Jones (*6*) found that preschool children were able to match both letters and words more accurately when color cues were added than when in black and white and that the children greatly preferred the task with color. He concluded that "Matching the black letters and black words was at least three times as difficult as the

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same task in colour, even allowing for colour matching . . ." (6:26) and suggested that the strong preference for colored materials is particularly important because of its potential value for motivation in early reading.

In another context, when Underwood, Ham and Ekstrand (*10*) used color-trigram stimuli in a paired-associate learning task, they concluded, among other things, that the addition of color served to enhance learning through cue selection, presumably because colors are more meaningful than low-meaning trigrams. Jenkins and Bailey (*5*) replicated the trigram-color stimuli portion of the Underwood, Ham, and Ekstrand study and concluded that both color and color names are effective stimuli even when subjects' attention is directed through spelling to the trigram portion of the trigram-color stimulus. Saltz (*9*), arguing that differentiation rather than cue reduction accounts for enhanced learning, deliberately suppressed the direct use of color cues in paired-associate learning by using color in either learning or test trials, but not in both. The data showed that color facilitated learning even when color could not readily be used as a cue, and the interpretation was that the facilitation was due to cognitive and/or sensory differentiation.

The implication of these studies is that children's paired-associate learning should be enhanced by the addition of color cues for any or all of the following reasons: aided perception and increased differentiation, the opportunity for cue selection, and greater motivation. Furthermore, there is the possibility that color may serve as a vehicle for mediation. A type of study exemplified by one in which Martin and Pryor (*7*) gave subjects mediating words with a paired-associate list provides a basis for such an expectation. Although the immediate concern of the study was not color cues, the mediating words did speed subjects' learning. The reasoning in the present study was that if both the stimulus and response portions of a paired-associate item were given in the same color, the color itself might serve as a mediator.

The basic purpose of the present study was to determine whether elementary school children's paired-associate learning would be enhanced by the introduction of color into the list. A secondary concern was whether good and poor readers' learning would be affected differently by the additional cue. The speculation was that poor readers might benefit from the color cue but good readers would not because they were already able to handle the task efficiently. The same reasoning would, of course, lead to an expectation of greater facilitation of learning for pupils in the lower grades. Because the study was primarily exploratory, there was no attempt to provide for clarification of reasons for possible differential effects.

The research design

The subjects were good and poor readers from Grades 2, 4, and 6 of a public and parochial elementary school in a small city. All potential subjects were required to have IQ's in the average range (90-115) according to test scores, corroborated by teacher judgment. Pupils with average IQ's who could not be clearly classified as good or poor readers were rejected as subjects. Good readers were those pupils who, according to test scores and teacher judgment, were in the upper third of their class in reading achievement; poor readers were those who were in the lower third.

From the population identified, equal numbers of boys and girls from each reading level and each grade level ($N = 72$) were assigned to the two methods of presentation. Thus, the design was 2 (boys and girls) x 2 (good and poor readers) x 3 (grades, 2, 4 and 6) x 2 (black-and-white and color presentation) with three replications.

The paired-associate list was devised and used in an earlier study (*8*). Briefly, the list comprised five pairs, a common geometric form, and a consonant-vowel-consonant trigram with a

25 percent or lower association value according to the Archer (*1*) list: *diamond-fep*, *circle-miv*, *triangle-wuc*, *star-yad*, *square-gox*. Depending on the method of presentation, both stimulus and response were presented either in black-and-white or in color. Colors used, in the same order as the above list, were blue, red, brown, orange, and green.

Individual subjects learned the list to a criterion of one correct anticipation of the entire list with serial presentation and one correct anticipation of the entire list with scrambled presentation. The total score, then, was the sum of serial and scrambled trials. This unconventional sequence of presentation was devised when immediate scrambling of the list proved disconcerting to younger subjects.

A MTA-100 Scholar timed by a Cousino Audio Announcer was used to present the list. An overlay with a 7" x 1" opening was affixed to the display face of the Scholar. By manipulating a slide, the experimenter was able to expose 1½" x 1" portions of the total opening; and the stimulus sheet was so arranged as to permit five different orders of presentation. Figures and trigrams were ⅜" high. The stimulus form was presented for four seconds followed by a four-second presentation of both stimulus form and response trigram, during which presentation the experimenter enunciated the trigram name. Each pair was followed by a four-second rest, and each presentation of the entire list was followed by a sixteen-second intertrial rest.

All testing was done in a private room with a minimum of distraction. Subjects were told that they were helping the experimenter to learn how children learn. The fact that the pairs would be in black-and-white or in color was not pointed out, and the fact that color was used was never spontaneously mentioned by a subject. A preliminary trial with a stimulus pair (*heart-keb*) was given to explain the nature and sequence of the task. All subjects were tested by the writer.

The results of the study

The mean acquisition trials—serial, scrambled, and total—are given by main effect in Table 1. It should be noted here that the grand mean for total trials was 9.7; but, with visual-auditory presentation in an earlier study (*8*), in which the task and method of presentation with the exception of the added color cues were the same as in this study, the grand mean for the visual-auditory group ($N=36$) was 12.3. This discrepancy between the results of the present and the earlier study is noted because there are implications for the interpretation of the present findings. Other specific discrepancies between the two studies are noted for the same reason.

Separate analyses of variance of serial and of scrambled trials showed that only the Grade and Reading Level main effects were significant ($p<.005$) with serial trials; none was significant with scrambled trials; and there were no significant interactions shown in either analysis. The effect of scrambling the presentation apparently was the same for all subjects, with the initial serial learning trials accounting

TABLE 1

MEAN ACQUISITION TRIALS

	Grade			Sex		Level		Method	
	2	4	6	M	F	G	P	B-W	C
Serial	8.5	6.7	5.9	6.8	7.2	5.9	8.1	7.2	6.9
Scrambled	3.0	2.2	2.6	2.8	2.5	2.4	2.9	2.8	2.5
Total	11.5	8.9	8.5	9.6	9.7	8.3	11.0	9.9	9.4

for the differences. The analysis of variance of total learning trials is summarized in Table 2. Again, only the Grade and Reading Level main effects are significant, and none of the interactions reach significance. Table 1 shows that second graders took more trials than fourth and sixth graders, but there is little difference between fourth and sixth graders' mean trials. This finding, too, is different from the earlier study where second, fourth, and sixth graders all differed. The poor readers required significantly more trials than the good readers to master the list, but again there is a possibly significant discrepancy from the earlier results. In the present study good readers required 8.3 and poor readers required 11.0 mean trials; whereas, in the earlier study good readers required 8.7 and poor readers required 15.3 mean trials. Thus, the good readers in both studies performed similarly, but the present poor readers required substantially fewer total trials.

The Method of Presentation main effect did not approach significance, nor were any of the interactions significant. Yet, in view of the speculation that perhaps poor readers and lower grade pupils would benefit most from color cues, the following interaction tables show some interesting trends. The means in Table 3 show that it was the good readers who tended to benefit more from color cues; and the means in Table 4 show a trend toward increasing benefit from color cues with increasing grade level. Both trends are directly opposite from the prestudy speculation.

Discussion

Because the analyses revealed that the present results were generally nonsignificant, very little that is unequivocal can be said. Yet the expectation that more efficient paired-associate learning should result from the addition of color cues is based upon sufficiently strong theoretical and empirical grounds to make examination of the present contradictory results worthwhile. *Post hoc* speculation, then, is offered with full awareness of the limitations.

TABLE 2

ANALYSIS OF VARIANCE OF TOTAL LEARNING TRIALS

	DF	MS	F
Grade (G)	2	64.125	11.400*
Sex (S)	1	.222	–
Reading Level (L)	1	133.389	23.714*
Method of Presentation (M)	1	5.555	–
G x S	2	7.680	1.365
G x L	2	6.097	1.084
G x M	2	4.180	–
S x L	1	20.055	3.565
S x M	1	.888	–
L x M	1	6.722	1.195
G x S x L	2	1.930	–
G x S x M	2	8.847	1.573
G x L x M	2	1.930	–
S x L x M	1	.500	–
G x S x L x M	2	6.542	1.163
Within	48	5.625	

* $p < .005$

TABLE 3

MEAN TOTAL TRIALS: READING LEVEL X METHOD OF PRESENTATION

Reading Level	Method of Presentation	
	Black-White	Colored
Good	8.9	7.7
Poor	11.0	11.1

TABLE 4

MEAN TOTAL TRIALS: GRADE X METHOD OF PRESENTATION

Grade	Method of Presentation	
	Black-White	Colored
2	11.4	11.7
4	9.2	8.7
6	9.3	7.8

Because the experimenter did not point out or discuss the color cues, it would have been necessary for individuals to discover their own use for the color cues. Not one of the subjects commented on the varied colors. When the experimenter informally queried some of the subjects several days after the testing, they were unable to recall whether the task had been presented in black-and-white or in color. The follow-up was not done systematically, but the informal feedback suggests that perhaps the subjects did not use color cues either because they were frankly not consciously perceived or because they did not see a way of making systematic use of them. Of course, there is a possibility of "unconscious mediation," as demonstrated by Bugelski and Scharlock (*4*); but it apparently was not strongly operative in this study. Yet, if the argument that the subjects were unaware of the color is to stand, the trends noted—i.e., more efficient learning with color cues by good readers and upper grade pupils—must be explained in terms of unconscious mediation. A replication of the present study with explicit instructions regarding color cues would be worthwhile.

Another possibility is that as the present paired-associate task was structured, the interjection of color did not amount to provision of a more meaningful or more useful cue. Dissimilar geometric forms served as stimuli in the present task; whereas, in the related studies which were reviewed trigrams were the stimuli, and color was added only to the stimulus portion of each pair. The geometric forms used here were dissimilar by design and, therefore, perhaps so discrete that further differentiation or cue selection was not useful. Of course, the present list was also atypical in that both stimulus and response components were in color. The reasoning was that this arrangement might encourage color mediation, but the effect may have been merely to erase the salience of color as a cue. The foregoing, unfortunately, does not explain the lack of any motivational effect arising from the use of color; but perhaps only very young children, such as those studied by Jones (*6*), benefit directly from color in this way.

To offer an explanation for the unexpected trend by good readers and upper-grade pupils to do better with color is difficult. The speculation already given is, if anything, at odds with this trend. One could dismiss it as nonsignificant; but the fact is that the trend is opposite from that expected and, therefore, particularly unserendipitous. Another study of good and poor readers' paired-associate learning is needed to determine whether the trend is a stable one. If it is, then further efforts to determine the reason will be in order.

In another study it would be interesting to examine the effect of permitting subjects to choose the particular colors that will serve as cues. Beck (*2*) has reported on research which suggests that some colors are more commonly associated with certain concepts than other colors; and Beck and Dunbar (*3*) found that their subjects tended to associate the same color with each word in a pair of synonyms and that tenth graders and college students did so more consistently than sixth graders. Perhaps if subjects were permitted to choose the colors they feel should be associated with stimulus portions of the pairs on a paired-associate list, they would learn the list more efficiently than subjects who were given arbitrary color cues.

Finally, the present subjects took fewer trials, regardless of method of presentation, to master the list than did subjects who learned the same list in the earlier study. As already noted, however, the means for good readers in the two studies were very similar: the difference was between poor readers' means, with the present subjects taking substantially fewer trials. Obviously, there was some discrepancy between either the choice of poor readers and/or the administration of the task in the two studies. The most straightforward suggestion is that the present poor readers may have been better readers. Poor readers in the earlier study were chosen from among pupils whose reading test scores placed them in the bottom three stanines on national norms; whereas, the present poor readers were from the bottom third of their classes according to test scores and teacher judgment. The discrepancy is relevant here mainly because different results might have been obtained with regard to color cues if the poor readers had been pupils with severe reading problems.

The contribution of the present study is obviously not to be found in its immediate results: there was no support for the expectation that the provision of color cues would enhance paired-associate learning in general or for the notion that poor readers might benefit disproportionately from the added cue. Yet the restrictions of the task employed and the need to increase the salience of the color cues are now more clearly understood.

A possible next step is to employ a more reading-like task—e.g., pairs comprising a word-like stimulus and a verbal response—to examine the possible effect of color cues upon paired associate learning that is much like basic sight word learning. Such a study and others like it should lead to more intelligent uses of color in the teaching of reading, particularly in remedial reading if poor readers do, in fact, benefit from the added cue. Furthermore, clarification of children's uses of a specific cue like color will have implications for studies of the role of other types of cues.

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Perceptual Systems in Reading: The Prediction of a Temporal Eye-Voice Span*

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THIS PAPER DESCRIBES in part a study (*2*) which attempts to arrive at an un-

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derstanding of how perception in reading takes place more clearly than that proposed by classical theory. Classical theory of perception in reading was a landmark of educational research and a giant step forward in understanding reading phenomena. However, it was a step taken originally in 1885, based on assumptions known to be oversimplified today and upon interpretations of empirical data which modern control procedures have called into question.

Until recent years neurologists believed the visual system to be relatively simple. The eye was commonly compared to a camera in which the retina reacted to light in much the same way as a photographic plate. It was thought that these reactions were transmitted instantaneously to the projection areas of the brain in a point-by-point mosaic representation. Early investigators, basing their interpretations on these assumptions, believed perception to be a unitary phenomenon with all parts of the visual field being perceived instantaneously and simultaneously. Much of the experimentation involved tachistoscopically measuring the span of attention in order to isolate the "elemental perceptive act." From these experiments the concept of the visual span of perception was derived with the accompanying belief that within each span, words were recognized by "general word shape" or "total word picture." The ongoing reading process was conceived as a series of tachistoscopic presentations flashed to the brain by the saccadic movements of the eye. Improvement in reading was seen as "depending on the instantaneous recognition of larger and larger blocks of letters" (*5*).

Today, through the work of neurophysiologists and electrophysiologists, the enormous complexities of the visual system are beginning to be appreciated. The retina, alone, is known to be such a dynamic and complex organ that Granit (*3*), director of the Nobel Institute of Neurophysiology, referred to it as the "little brain." Psychophysicists and other investigators interested in the field of sensory psychology have been systematically working out the details of the variables affecting tachistoscopic and related experimentation. Using instruments and control procedures unknown to the early theorists, modern investigators have found that visual perception functions in much more complex and dynamic ways than those suggested by classical theory. This continual search for deeper meanings is a basic part of the scientific process.

Theoretical background

The theoretical background and stimulus for this study were derived from two sources: General Systems Theory as applied to reading in the Substrata-factor Theory of Holmes (*6, 7, 8*) and Information Theory as exemplified by the Filter Theory of Broadbent (*1*). The Substrata-factor Theory of Reading is a comprehensive view of the reading process which has been shown by Kling (*9*) to match the Organismic Open Systems Model of General Systems Theory at each point. While emphasizing that reading is a processing skill, Holmes and his coworkers engaged in research designed to identify statistically the relationship between the many organismic systems postulated as operating in reading at a hypothetical instant in time.

Using the Substrata-factor Theory with its concepts of interacting systems as a general frame of reference, it seemed equally valid to limit experimentally the complexity of the reading task in order to trace a minimum amount of information across time. This is essentially the approach taken by the information theorists. Contrary to the classical position that the perception of overlearned materials takes place instantaneously, a model constructed from this theoretical viewpoint would hold that perception requires time. Such a model would attempt to identify the directly interacting systems operating during the ongoing minimal reading process. A major concern of the model would be the prediction of the temporal relationships involved in the processing of a series of stimuli.

The purposes of the study

Specifically, the purposes of the study were as follows:

1. To construct a heuristic model of perception in reading from an analysis of the published research which would explain better than the classical theory the apparent dynamics and account for more of the known facts in the perception and identification of visual-verbal stimuli during reading.
2. To synthesize certain aspects of the model with those parallel postulates of the Organismic Open Systems Model which deal with the establishment and maintenance of a steady state in order to generate experimentally testable hypotheses that delineated specific time constants and dealt with the dynamics of the perceptual process.
3. To experimentally test the validity of the generated hypotheses.

The model

From an analysis of classical and modern research, a heuristic model was constructed which delineated the directly interacting systems postulated as functioning during oral reading. As much of the data concerned with visual perception stems from tachistoscopic studies, it was necessary to analyze minutely the variables affecting tachistoscopic reports in order to understand the relationships of the findings of these studies to normal reading. A schematic outline of the model is presented in Figure 1.

The model as outlined can be differentiated logically into three major processing functions, viz., sensory, recognitional, and response. Each of these systems has a hypothesized characteristic rate of operation, thought of as being based on physiological functions inherent in the organism. Interspersed between these three systems are two storage systems which

S	
Initial (Sensory) Scanning System	Processing Rate: Approximately 8 ms. per letter-space
Sensory Organizational Systems	
Initial (Sensory) Storage System	Limit: Approximately one second.
Recognitional (Internal Response) System	Processing Rate: Approximately 250 ms. per unit.
Secondary (Internal Response) Storage System	Limit: Several seconds
Response System(s)	Processing Rate: Dependent upon response required. Oral reading, about 300 ms. per unit.
R	

Figure 1. Block Diagram of Heuristic Model

make smooth information processing possible by acting as temporal buffers which allow the integration of the different rates of the processing systems. Specifically, the model postulates that between the moment in time when a stimulus is sensed and when it is reported, the following dynamic systems tend toward an overall steady state:

1. An *Initial (Sensory) Scanning System* operating at a hypothesized rate of 8 ms. per letter-space. Although initially volitional in direction, this purely attentional input system becomes conditioned to scan reading material in the direction in which the language is written. The postulated scanning action takes place *within each fixational pause*, the saccadic movements being vital to keeping the visual apparatus in a position where the covert or attentional scanning is within the retinal area of fine discrimination.
2. A *Sensory Organizational System* whose function it is to organize and convert the scanned material into phonemic units.
3. An *Initial (Sensory) Storage System* capable of storing the phonemic stimulus units as a fading memory trace for a hypothesized period of *one second* and, consequently, acting as a temporal buffer between the preceding and succeeding systems.
4. A *Recognitional (Internal Response) System*, thought to operate in silent reading at a rate of approximately 250 ms. per response, which converts the fading stimuli in the storage system to a more permanent form.
5. A *Secondary (Internal Response) Storage System* capable of storing the internal response for several seconds and, consequently, operating as a temporal buffer between the internal response and report when needed. It was assumed that this system would receive minimal use during smooth, oral reading, as the systems governing the oral response would be directly coupled to the Recognitional System.
6. An *Oral Response System* which organizes the complex musculature involved in speech.

The dynamics

The overall function of the visual system is to allow the organism to make meaningful responses to the environment as visually perceived. In order to respond, a large number of elements in the visual field must be extracted and organized into meaningful units which can themselves be organized into larger entities. Since the recognitional system can organize a number of sensory elements (e.g., letters) into a single response unit (e.g., a word or phrase), the sensory system must be capable of a much higher rate of operation than the recognitional system.

In the tachistoscopic situation, if 12 letters were flashed to a subject during a 100 ms. presentation, they could be covertly scanned at the hypothesized rate of 8 ms. per letter-space in approximately 96 ms. and would briefly be stored in the initial storage system. If the letters were random so that a separate response was required for each, the subject might respond to three or four letters during the storage period available; but the remainder of the letters would be lost, leaving the subject with the vague impression that he had "read" them all but had forgotten some before he could report them. However, if the 12 letters were stored as two or three short words, this number of responses could be made within the hypothesized one-second storage capacity of the initial storage system; and the subject could respond to them all.

In continuous reading, once the subject had scanned an amount equal to his storage-response capabilities, the effective rate of further scanning would depend upon the rate of processing of the slowest systems. If input proceeded too far ahead of the response system or if recognitional or response difficulties arose, the scanned elements would be lost from storage before they could be responded to, and the subject would be required to make a regressive eye movement in order to scan again the lost elements. *In smooth reading, then, the systems would achieve a balance between the sensory and response systems. This balance would be dependent upon the time available in the initial storage system* in its hypothesized role of buffer between input and output. That is, for the eye to track smoothly without regressive or refixative movements, each successive response would have to be made within the one second during which its respective stimulus was available. In order to provide for maximum buffering action, it would be advantageous to make full use of the storage time. *Smooth reading, therefore, would be characterized by a relatively constant one-second, temporal eye-voice span regardless of the number of words or syllables being processed within that span.* It is at this point that the heuristic model developed in this paper synthesizes with those postulates of General Open Systems Theory which are concerned with the establishment and maintenance of a steady state.

The hypotheses

From the above rationale two major experimental hypotheses were generated:

H^{I}: During smooth oral reading, the *temporal* eye-voice span a) will remain relatively constant and b) the period of time separating the eye and voice will approximate one second.

H^{II}: In those situations where an interruption of smooth, balanced reading occurs as evidenced by an overt error or pause in the voice, the eye will take corrective action and then the systems will quickly reestablish the pre-interruption balance.

Since "smooth reading" is a relative judged from eye-movement patterns and since an unknown amount of error variance was inevitable, Hypothesis I^{a} was tested by testing the following subordinate hypotheses:

(1) Between subjects, those reading more smoothly as evidenced by relatively smooth eye-movement patterns will also evidence a relatively more constant temporal eye-voice span.

(2) Between passages read by the same subject, those passages read with relatively smooth eye-movement patterns will also evidence a relatively more constant temporal eye-voice span.

(3) Within passages read by the same subject, those temporal eye-voice spans associated with smooth reading will be more constant than those associated with non-smooth reading.

The observations

Data to test the above hypotheses were derived from 2,465 eye-voice span pairings furnished by eight subjects reading three passages of varying difficulty aloud before the Gilbert Eye-Movement camera. This camera reflects a focused beam of light from the cornea of the reader to 35 mm. movie film. A revolving shutter, powered by a synchronous motor, breaks the beam of light thirty times each second. A second beam of light reflected from a silver bead mounted on a pair of lensless spectacles allows the correction of errors due to lateral head movements. The developed film is projected onto a copy of the reading material enabling the point of regard of the eye to be determined for each one thirtieth of a second of reading time.

During the reading, the voice was recorded by a Wollensak Stereo Tape Recorder. A specially designed modification to the camera provided simultaneous markings on film and tape at the moment of command to begin reading and every two fifths of a second thereafter. All eye records were plotted on graphs of elapsed time prior to the analysis of voice records. The modification to the camera and improved methods of plotting developed during pre-experimental validation procedures exposed two hitherto unreported sources of position error thought to be common to all corneal-reflection techniques.

Voice tapes were played through a speaker and a Grass Model No. 7 Polygraph adjusted to react to varying volume. The resulting pen markings were plotted by the polygraph on a moving graph paper which showed elapsed time. These records were then transferred to the elapsed time graphs on which the eye data had been previously recorded. The modification to the camera allowed the synchronization of the two records to be validated each two fifths of a second of elapsed time. The completed time graphs showed the simultaneous action of eye and voice during each one thirtieth of a second for the entire passage. Measures of temporal eye-voice span were obtained from these time graphs.

Validation of eye records

The modification to the camera had the additional effect of making possible considerably more accurate plotting. The Gilbert Eye-Movement Camera gives no measure of vertical eye and head movements. Often a number of dots are registered as an undifferentiated mass due to these movements. By developing and utilizing a system of plotting in terms of both dots and blanks, this type of error was corrected.

The increased precision in plotting revealed the following two sources of position error not previously reported in the literature which subsequent analysis showed to be inherent in corneal reflection techniques:

1. It is common practice in plotting eye movement records to depend upon perpendicularity of film to type line as a means of alignment. Corrections for head movements are made by keeping the dots made by the head bead positioned on a line drawn during calibration. It is assumed that the head dot just opposite to the eye dot being counted is the proper dot for alignment. An examination of the blanks showed this assumption to be erroneous and a possible source of considerable position error. It was found that accuracy could be achieved only by matching each eye and head dot and counting dot by dot. This procedure would have been impossible without the periodic simultaneous blanks.

2. In plotting validation records dot by dot, a second source of error was discovered. On some records this error appeared as a line-by-line displacement to the right accompanied by an increase in the size of the field. Other records showed a displacement to the left accompanied by a decrease in field size. A third pattern was a combination of the other two, the field first expanding and then contracting in a truncated diamond shape. These pattern differences were apparently the result of small differences in the placement of the light source on the edge of the cornea.

Several sources combine to indicate that these errors are inherent in corneal reflection techniques. First, the dots produced by the head bead were unaffected regardless of the location of the head bead, showing that the phenomenon was not an artifact of the camera, film, or projector. Second, conferences with the scientists at the University of California Medical School Developmental Laboratory confirmed that the records produced by equipment under development there showed the same patterns. This equipment had nothing in common with the eye-movement camera except the corneal-reflection technique. Third, conferences with members of the faculty of the University of California School of Optometry verified that such aberrations could be caused by the differing angles produced by moving a point of light across different horizontal surfaces of the cornea.

As it was apparent that the usual procedure of using the head line for line-to-line calibration introduced a sizeable and systematic error, this procedure was abandoned. Instead, an assumption was made that for each line the outermost fixations were on the outermost words. While this assumption no doubt introduced error of its own, it had the advantage of randomizing and probably reducing systematic error.

Measurement procedures

All eye-movement film records were processed before the voice records were prepared. The films were plotted using the dot-by-dot comparison of eye and head dots previously mentioned. The time involved in saccadic movements and return sweeps was not included in the pauses unless a movement took less than one thirtieth of a second to complete. Time records were kept in terms of both dots and blanks, to allow a constant check on accuracy. When all eye films had been plotted, the data were transferred to graphs of elapsed time to which the voice data were later added.

The tapes of the subjects' voices were played at half speed through the polygraph. A foot control mechanism on the tape recorder allowed the tape to be stopped after brief intervals so that the sounds associated with the curves drawn by the pens could be recorded on the polygraph paper. Particular attention was paid to the blends of words. It was apparent from the polygraph records that speech patterns do not exactly follow the way in which written language is separated into words. Since this study was of reading, speech was recorded in the word units of written language. This procedure often necessitated replaying a particular blend in order to estimate the exact point at which one word became another.

Once the curves of the polygraph records were identified, the beginning and ending time of each word was recorded on a separate form. A correction factor, if needed, was calculated from the chronograph records and applied to the data. When the voice records of all subjects were so identified and measured, these data were added to the graphs of elapsed time containing the parallel eye data. These completed graphs of elapsed time were the basic data from which the evidence testing the experimental hypotheses were derived. They are believed to be the first complete records of eye-voice span ever taken.

Sources of error variance

The impossibility of conducting experimentation without error is well known. Certain features of the experimental techniques employed in this study made considerable error inevitable:

The eye-movement camera. Calibration studies which preceded experimentation showed clearly that the eye-movement camera is capable of very fine measurement. The fact that the camera could demonstrate the error inherent in corneal reflection techniques is significant. Yet this error remains to an unknown degree. No cornea is perfectly spherical, and any departure introduces error. These errors were enhanced and randomized by the constant small vertical head movements which occur during speaking.

Fixation input error. The camera identifies the point of regard and the length of each fixation. It cannot identify the number of words being sensed or whether these words are centered on the point of regard or are preponderantly to right or left. More important for this study, it cannot tell at what precise moment during a fixational pause input takes place. Temporal eye-voice span was arbitrarily defined for the purposes of this study as the length of time accruing from the beginning of the eye fixation to that point in time when the voice had completed speaking the word falling under the point of regard. By imposing a fixed rule on a flexible function, some amount of error results inevitably.

Fixation without input. In many cases several fixations were associated with a single response. While it is probable that only one of these multiple fixations resulted in a response, it is by no means simple to determine which one. It was felt that the most objective decision in these cases would be to plot an eye-voice span from every fixation in order to yield a mean of the multiple fixations as an estimate of the point of beginning. While this decision should not have affected unduly the overall means, it would enlarge the standard deviations.

Some fixations appeared to be for the purpose of "marking time" only. A few regressive fixations, centered on words already spoken, yielded a negative eye-voice span. To include these spans in the total would inflate the standard deviations considerably. Yet there was no objective, unambiguous evidence that these fixations were in fact nonproductive; and they were included in order to avoid the subjectivity inherent in a decision to eliminate them.

Consequently, every fixation made by every subject was used to measure a separate temporal eye-voice span. The fixations which appeared to be nonproductive commonly yielded very large or very small spans. While it is obvious that a fixation centering on a word which has already been spoken could not have produced the input for that word, these negative spans were included as a statistical balance for the equally questionable long spans. This procedure was deemed necessary to avoid a situation where a hypothesis concerning the constancy of the eye-voice span is tested by eliminating those spans not constant.

To test Hypothesis I^a, a measure of smoothness of reading and a separate measure of constancy of the temporal eye-voice span were needed. Since a relationship had been hypothesized between these two functions, it was necessary that the measures selected bore no arithmetical relationships to each other. It was decided to class multiple fixations and regressions together as evidence of non-smooth reading and to consider single, forward fixations as evidence of smooth reading. Relative smoothness of reading between subjects and passages was judged, therefore, on the percentage of single, forward fixations to the total number of fixations. An obvious measure of constancy of temporal eye-voice span would have been the coefficient of variation ($V = \frac{\sigma}{m}$). In order to be more consistent with the direction in which the hypothesis was stated, however, the reciprocal of this statistic was used and identified as the coefficient of constancy ($C = \frac{m}{\sigma}$).

Hypothesis I^a, which stated that during smooth oral reading the temporal eye-voice span would remain relatively constant, was supported by the data on each of the three subordinate hypotheses. Between subjects, rank order correlations between measures of smooth reading and constancy of the temporal eye-voice span were .83, .98, and .90 for the three passages individually and .95 for the combined passages. Between passages read by the same subject, the relationships were apparent but not so strong. Perhaps the clearest indication of the strength of the relationship was gained by pooling all subject-passage comparisons, regardless of subject and passage differences. The resulting rank order correlation of the 24 pairs was .93. Examination of the spans associated with smooth and non-smooth reading showed that in 23 of the 24 comparisons those spans associated with smooth reading were more constant, as hypothesized.

Hypothesis I^b, which stated that the period of time separating the eye and voice in smooth reading would approximate one second, was likewise substantiated. Table 1 presents these data. The mean temporal eye-voice span for all subjects reading all passages was 1004 ms. For the three passages combined, the means for the eight subjects ranged from 904 to 1088 ms. With subjects combined on each passage, the mean temporal eye-voice spans were 909, 1033, and 1024 ms.

Hypothesis II, concerned with a reestablishment of the steady state following an interruption of it, was not statistically testable from these data. However, examination of the individual reading time graphs showed that the subjects used multiple fixations, regressions, and overly long fixational pauses in characteristic ways at the be-

TABLE 1

MEANS AND STANDARD DEVIATIONS OF TEMPORAL EYE-VOICE SPANS AND NUMBER OF FIXATIONS FOR EACH SUBJECT ON EACH PASSAGE

Subjects	Passage 2			Passage 3			Passage 4			All passages		
	$\bar{X}$	SD	N	$\bar{X}$	SD	N	$\bar{X}$	SD	N	$\bar{X}$	SD	N
1	953	304	80	943	357	155	953	354	178	949	345	413
2	787	133	50	927	207	99	938	258	103	904	213	252
3	777	258	58	997	295	106	988	277	111	947	280	275
4	989	182	53	1147	277	118	1061	249	120	1083	248	291
5	925	317	74	1114	416	142	1098	367	159	1070	376	375
6	882	217	53	1056	325	110	995	286	116	998	288	279
7	824	277	58	983	301	100	1049	315	108	975	301	266
8	1075	273	68	1078	347	118	1103	362	128	1088	337	314
All Subjects	909	254	494	1033	323	948	1024	315	1023	1004	305	2465

ginning and completion of reading, at the ends of sentences, and at points of error. These graphs showed clearly that in reading under the conditions of this experiment, a significant portion of the eye-movement pattern is related to a necessity to balance temporally input and output systems and that at points of error or at voice pauses, the eyes must take some corrective action in order to maintain or reestablish the temporal balance.

Conclusions

It was concluded that the time estimate of one second for the temporal eye-voice span was essentially correct and that the data supported at each point the aspects of Hypothesis I, relating the constancy of this span to smooth, oral reading. It was also concluded that the eye and voice interactions revealed in the reading charts supported Hypothesis II concerning the reestablishment of a temporal balance following an interruption.

The demonstration of the steady state phenomenon in the oral reading act and of the flexibility of the input and output systems in maintaining the necessary balance would seem to add verification to the application of the Organismic Open Systems Model to reading, as done in the Substrata-factor Theory by Holmes. The data, if replicable, would also seem to support those portions of the heuristic model tested, although other explanations may be possible.

Concluding statement

While explaining the model presented in this paper to teachers, the experimenter has been invariably asked about its relevance to the teaching-learning situation. It may be of some importance, therefore, to state specifically that as yet the model has little to offer the teacher. The model in its present form is quite tentative and incomplete. The experiment reported in this paper did not test all parts of the model and certainly not all kinds of reading. The experiment, itself, is in need of replication.

The model at present is a heuristic device. It explains classical experimental data as well as classical theory and, in addition, explains a number of long-known phenomena which classical theory failed to explain. It is consistent with recent experimental findings which appear inconsistent with classical theory. Most important, it predicted and identified what is probably the central and unifying measure in eye-movement analysis, a measure which had been ignored during 70 years of research because classical theory gave no indication of its importance. These considerations allow some hope that the lines of research suggested by the model may add to the cumulative knowledge of reading phenomena and, perhaps, eventually suggest new approaches to teaching methodology. Serious speculation at this stage, however, would be premature at best.

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Visual Hazards in the Early Teaching of Reading

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MANY CHILDREN actually begin to learn to read before the age of six (18:237). By way of summarizing the literature, Holmes said, "Under favorable conditions, *normal* children *can be* taught to read before the age of six years, perhaps as early as the age of two or three," but to do so requires that for younger and younger children there must be smaller and smaller teacher-pupil ratios. That is, the age at which children of average intelligence can learn to read by any method seems to be an inverse function of the actual supervised time the child spends every day in reading—other things being equal. However, in addition to establishing the fact that children under certain conditions can learn to read at an early age, Holmes gave some attention to the *advisability* of teaching them to do so. That part of his inquiry was in terms of curriculum sequence and educational philosophy.

The specific question with which this paper is concerned may be put thus: In teaching the child to read before the age of six, does one increase the risk of damaging his eyes—perhaps for life?

Buswell (*4*) made the reason for concern particularly clear when he wrote, "The unique characteristic of reading lies in its perception rather than comprehension. Comprehension is an overall factor that applies to listening and thinking as well as to reading. The new element encountered in learning to read is the perceptual recognition of the printed verbal symbols." (4:103). It follows, therefore, that *if* an undue amount of strain is placed upon immature eyes when the child is taught to read too soon, then the sense organ that makes reading possible may be irreparably damaged. The concern of this paper is with the early teaching of reading and the sub-

[1] This paper is part of an ongoing longitudinal study conducted under the direction of the writer and supported by a grant from the Carnegie Corporation of New York and the University of California. Thanks are accorded J. Ong, Research Assistant, for searching out some of the earlier literature. Similar thanks are accorded by assistant, Walter Coffey, and Elizabeth Caloroso, Assistant Clinical Professor of Optometry, University of California, for their part in tracking down some of the later references.

sequent development of or increase in errors of refraction or neuromuscular anomalies.

No research dealing with the specific visual problem in children who have learned to read *before vs. after* the age of six has been located. This is the experimental approach that must be taken in the near future if one continues to stress the early teaching of reading. Nevertheless, research has dealt with a closely allied problem: What accounts for the observed fact that refractive changes, especially myopia, actually do take place in the eyes of children as they go through school? To what extent are such changes related to eye strain, close work, maturational development, and heredity? The problem was recognized in 1867 when Cohn examined 10,000 German school children and noted the absence of nearsightedness when the children entered school and its prevalence among children in the higher grades. To account for this observation, he postulated that the use and abuse of the eyes in close work at school constituted the major cause of this increase in myopia.

Ochapovsky (*34*) pointed out that during the growth of a human being, changes in refraction take place which are based on several factors. The rate of change is greatest in early childhood, gradually waning as the individual grows into adulthood and senility. Ochapovsky stated:

> The *cornea* shows only a relatively small growth from the infantile stage to that of the adult, having to increase in size only by one fifth or one fourth to obtain the final value, which is reached by the *third* year of life. . . . However, individual variation in *corneal curvature* is large and may amount to 10 diopters[2] and more.
>
> The *lens* undergoes great variations during its developmental cycle. Paralleling the growth of the entire eyeball, the growth of the lens proceeds most rapidly during the *first* year, but in contrast to that of the cornea, it never ceases. The lens gradually increases in the equatorial direction and diminishes in its thickness and curvature, becoming *less* powerful as a refracting body.
>
> The *sagittal axis* of the eye is subject to even greater changes and these vitally affect the refraction. The average sagittal diameter of the infant's eye is 17.5 mm.; that of the developed adult eye is from 23.8 to 24.3 mm., an increase in length of from 6.3 to 6.8 mm.
>
> The elongation of the *anteroposterior* axis proceeds irregularly, the increase being most intensive during the period of strongest growth of the whole organism. The growth of the cornea and of the lens tends to weaken the dioptic power, but the elongation of the eyeball compensates for this by receding the retina, bringing on a relative or an actual myopia. . . .

The foregoing statement would be closer to modern theory if it were stated in the opposite form; that is, recent experiments extend earlier embryological studies and indicate that while the retina is the initial lead tissue in the development of the eye, its maturation into a physiological and fully functioning unit is the result of many interactions, mutual induction processes, and causal chains and indirect feedbacks.

Concerning the interactions in the induction process (by chemical organizers) and also the effect of the intraocular pressure, Jankiewicz (*20*) quoted Coulombre (*6*), "The analysis of each tissue as both a source and a target of influence permits the construction of flow sheets of tissue interactions in the developing eye. These flowsheets provide a national basis for understanding the teratology of this organ and represent causal chains which must connect at many points with events at molecular and chromosomal levels." Since the eye is an anatomical, physiological extension of the brain, those interested in reading theory should note that the type of reasoning behind Jankiewicz's and Coulombre's statements is precisely like that which underlies the Substrata Factor Theory of Reading (*16, 17*).

In contrast to Cohn's use and abuse theory, Ochapovsky's thesis is that the

[2] A diopter is a unit used to express the power of a lens and is equal to the reciprocal of the focal length when measured in meters. For example, if a lens will bring parallel rays of light into focus in 10 centimeters or 1/10 meter, its power would be 10/1 or 10 diopters.

growth changes in the eye are largely predetermined by heredity, preserving in its different elements, and often in its whole, the features inherited from ancestors according to the rules of hereditary transmission. It is thus easy to understand the diversity of refraction among members of the same family as well as among mankind generally. After reviewing the evidence associated with DNA and RNA Jankiewicz concluded, "*Granting that nutrition, disease, nature of one's sensory and motor activities, and other environmental factors have some effect on refractive status, it is my guess that these are associated with a solid group of genes to determine the refractive status.*"

Ochapovsky (*34*) delineated the arguments supporting the various notions in the controversy over the genesis of refraction. His two most serious arguments include the following:

> One school teaches that myopia develops as a result of the excessive growth of the eye in its front-to-back diameter under the influence of intensive near work. According to this school, myopia may be controlled and prevented by adequate hygienic measures and by elimination of the predisposing exogenous conditions.
>
> The other school holds that myopia is subject to the laws of ontogenesis,[a] just as hyperopia (farsightedness) and emmetropia (normal vision) are. That is, the values of the basic refractive components are determined by heredity. Myopia, according to this argument, is not an acquired property but, like other types of refraction, is an inborn developmental pattern and, therefore, cannot be prevented from working out its predetermined growth pattern. It might be controlled by eugenic measures but not by hygienic ones.

The first school of thought supports its point of view by the fact that people engaged in close work generally are more nearsighted than those engaged in outdoor work. To the contrary, Ochapovsky argued that the dissemination of mankind over the face of the globe with its adaptations to various ecologic conditions has had no influence on refraction, but it is the individual differences in man's eyes that have caused him to seek work befitting his particular eye structure.

Hirsch and Weymouth (*10*), in an effort to understand the independent contributions which each part of the optic system made to refraction, reanalyzed the careful measurements that Stenström (*39*) had made on 1,000 right eyes in 1946. They stated, "The correlation coefficient of -0.76 (given by Stenström) is that between the state of refraction and axial length for a wide range of corneal radii. Partialing out the corneal radius elements raises this coefficient to -0.87." In their conclusion, they contend that approximately half of the variance in the refractive state is explained by variation in axial length, a fourth by the corneal curvature, and a twentieth by the depth of the anterior chamber. The rest, one fifth, must be divided between variations in the crystalline lens, refractive indices, and errors of measurement. Studies following this pattern have led to the Biological-Statistical theory in an effort to account for all errors of refraction (*31*).

Stansbury (*38*) systematically reviewed the many theories relating to the pathogenesis of myopia. He commented that most of the theories have little in their favor and finally concluded that "One must abandon the monistic schema of myopia . . . and assume that there are two main types of myopia: one, a biologic variation, and the other, a pathologic disease of the eye." Stansbury further concluded that, 1) axial elongation of the eye beyond normal limits is not necessary to myopia; 2) near work has never been shown to cause myopia, either in school or in adult occupations; 3) the role of heredity is not definitely established, particularly with respect to secondary myopia; and 4) there is statistical evidence that primary myopia is a biologic variation, and the clinical evidence indicates that it is a healthy refractive state.

Hirsch, in a more recent article (*14*), wrote of these same two major types of myopia but cautioned that

[a] Development of the individual of a species from conception onward.

things are not so clearcut as this neat dichotomy would lead one to believe. Kawi and Pasamanick (*21*) tested the hypothesis that some childhood reading disorders were caused by minimal cerebral injury following abnormalities of the prenatal and paranatal periods.

Using 372 white male children with manifest reading disability and 372 matched controls, they sought differences in age, race, sex, IQ, reading levels, visual and audiometry tests, socioeconomic status, parental age, place of birth, previous maternal pregnancies, and previous maternal infant loss. Seventeen Baltimore hospitals supplied data on the complications of pregnancy, parturition, and neonatal period of certain subgroups within the matched samples.

The results indicated a significant relationship between later reading disorders in offspring and abnormal conditions associated with childbearing. Toxemias and bleeding during pregnancy constituted those complications largely responsible for the differences found between the cases and controls. Further, the cases had a significantly larger proportion of premature births than did the controls.

The findings of Kawi and Pasamanick are important because Eames (*7*) compared the eye conditions of ten-year-old children who had had premature, full-term, or hypermature births. He found that when compared to the full-term group, the hypermature group was slightly more exophoric[4] at reading distance, had slightly better acuity, and had less frequent hypermetropia. On the other hand, when compared to the hypermatures, the premature group exhibited a much greater incidence of poor vision and of myopia.

Kephart (*25*) and Kephart *et al* (*23, 24*) conducted a series of experiments with school children taking retinoscopic examinations at the beginning and end of the school year and again after the student had returned from vacation. The general conclusions that may be drawn from these three studies are the following: 1) There is a definite trend toward a greater percentage of myopia with increasing school experience; 2) Over the summer vacation the percent of myopia decreases, indicating a recovery from the myopia trend resulting from school experience; and 3) As the grade level increases, this recovery becomes less and less effective.

In direct contrast to findings of Kephart *et al*, Hirsch (*11*) did not establish such a relationship. On the basis of 840 randomly selected cases, he concluded that between 6 and 13 years the average refraction manifested a decrease in farsightedness at the rate of about 0.09 diopters per year. Furthermore, this rate was just as rapid during the summer months as during the school term. He concluded that close work in school has no association with the change in refraction.

In a more recent study in Russia, Litvinova, *et al* (*28*), after examining over 2,000 children from three to seven years, concluded that while myopia occurred rarely in the earlier age, its occurrence increased in frequency in the older groups.

Weymouth and Hirsch (*41*) collaborated on a paper dealing with the relative growth of the eye. In relation to the size of the eye to age, they indicated that the eye increases rapidly in size during the first year; reaches the minimum adult size, 20 mm., by two years; and that by five years most children's eyes are indistinguishable from those of adults. Further, they indicated that in the first year or two of life, there is a refractory shift toward hyperopia and in later childhood, a shift toward myopia. These statements agree in general with those presented by Keeney (*22*). On the other hand, Hirsch (*13*) stated, "Changes in refraction during the first five or six years of life are poorly understood," and that a long-term longitudinal study

[4] Exophoria is one of two types of *lateral heterophoria* in which the deviation of the covered eye is toward the midline. In esophoria the covered eye deviates toward the midline. Heterophoria is a binocular condition in which under ordinary conditions one eye turns away from the point looked at by the other.

of a random sample of children is needed.

Hirsch (*12*), in still another study, gave retinoscopic examinations to 9,552 randomly selected school children between five and fourteen. He concluded from the results of this investigation that the distribution of refraction is skewed toward the hyperopic side until the age of nine or ten, is symmetrical at this age, and as the children become older the curve becomes increasingly skewed toward the myopic side. Hirsch observed: "The increase in number of myopes seems to occur a year or two earlier in girls than it does in boys, as does puberty."

Young (*43*) found results similar to those of Hirsch so far as the double shift in the skewed distribution toward the hyperopic side until the age of 9 or 10, a symmetrical curve at this time, and then a skewing toward the myopic side with increasing age. Further, of the 652 children tested in a college town in a farming area, Young found that the children of college instructors show decidely more myopia than the children drawn from the farming population.

In a fourth interim report, Hirsch (*15*) retested at the age of 13 to 14 years those children first seen at five and six years. Of those children originally hypermetropic, nine percent had become even more hypermetropic; 79 percent had become less so or had become myopic. Hirsch also stated that a child with more than 2.5 diopters hypermetropia is unlikely to outgrow it.

Nadell and Hirsch (*32*), investigating 414 students, ages 13 to 18, attending a high school in Los Angeles County, showed that there are more refractive errors among children of homogeneous grandparental nativity than among children whose grandparents were born in different areas. That is, while myopia was more prevalent among the grandchildren of foreign-born grandparents, there was a greater number of hyperopic grandchildren for the American-born grandparents. These writers believed that their findings justify the following:

> Intermarriage seems to cancel the extremes of refraction, whereas marriage of those of like birthplace appear to enhance the deviation of the progeny from the modal refractive state. Furthermore, it appears to take more than one generation for this phenomenon to manifest itself, since the birthplace of the parents did not seem to be associated with the refractive state of the children.

In still another study, Nadell, Weymouth, and Hirsch (*33*) analyzed questionnaire responses regarding the amount of reading done by 409 ninth and tenth grade students and compared theirs to the refractive errors of younger children. The data failed to reveal any relationship between the amount of reading done and the distribution of the refractive state. The writers interpret this finding as supporting the biological rather than the environmental hypothesis of the origin of myopia.

Sorsby and Sheridan (*35*) made detailed measurements on refraction and its components during the growth of the eye from the age of three years. Their metric and correlational data on the development of the corneal and lenticular power, depth of anterior chamber, length of eyeball, birth weight, height, pigmentation, and sex throw some light on the possible mechanism underlying the development of myopia. The sclera and cornea together form the sphere of the eyeball, and a weakening (and, therefore, enlarging) of the lower and posterior part of the sclera is thought by Mann to be phylogenetically and ontogenetically associated embryologically with an "arrest in the final stages of scleral condensation. . . ."

From the work of Miller (*30*), it appears that the underlying defect in myopia is present at birth or soon after. To test this hypothesis, Miller investigated the influence of heredity, effects of prematurity, season of birth, exposure to ionizing radiation, etc. in 6,954 Japanese grammar school children, about half of whom were born of parents who were cousins. Miller concluded from his studies that "The prevalence of congenital organic lesions of the eye increased very significantly with inbreeding—from 1.69 per thousand for children of unrelated parents to 10.01 per thousand for children whose parents were first cousins." Further, about 80 percent of the myopic children with refractive errors but no organic lesion, showing 20/70 visual acuity or worse, showed a strong association to degree of parental inbreeding and a tendency to aggregate in families.

No association was discovered between the degree of myopia and maternal age or birth order; socioeconomic status; physical, neurological, dental development; or history of illness, but there appeared to be an increased risk of myopia when the birth weight was less than 2500 grams. Further evidence derives from a second study (not related to the main one) in which 4,407 children who had been exposed to A-bomb radiation in Hiroshima and Nagasaki were examined. Very significant correlations emerged between the distance from the epicenter of the bomb and the loss of visual acuity, with some unexplained peculiarities in the data. What is not clear is whether reduction in visual acuity was due to refractive change in the usual sense or to tissue damage due to radiation. Miller concluded that the "accumulated evidence to date suggests that myopia is attributable to a developmental flaw in the sclera." This conclusion was also supported by a study done in Germany. Lindner (*27*) advanced data which suggested that axial myopia is caused by the softening of the posterior part of the sclera due to choroidal sclerosis. He intimated that this process may be provoked by eyestrain, toxins, or by inflammation, especially when the posterior sclera is insufficiently protected because of a defective suprachoroidal layer. This is the predisposing factor.

Levinson (*26*), however, showed that when one lifted a water-filled balloon it would become elongated due to gravity and the flexilibity of the sack. Therefore, he indicated that when the head was tilted as in reading, the pull of the eye on a short optic nerve resulted in myopia. Following Levinson's experiments with dogs, cats, and rabbits, many other investigators have taken up this line of investigation.

These experiments, including his own, are well summarized in a recent paper by Young (*44*). Most of the modern work is done on monkeys, because like the human being, both eyes fall into a horizontal position when the monkey, enclosed in a close fitting box, is tilted so as to force the monkey to look at the floor. Young felt he was justified in making the following conclusions:

1. The type of visual environment to which the animal is exposed influences the proportion of myopia found and the degree of myopia developed.
2. Animals exposed to a restricted visual environment develop myopia faster, and a higher proportion of animals (approximately 75 percent) develop myopia than do animals kept in laboratory cages. But caged animals in turn develop more myopia than do penned animals which develop more than do wild animals.
3. There are sex differences in the amount of myopia developed in monkeys which parallel the sex differences found in humans.
4. The amount of myopia developed and time of onset of the development in restricted space situations are related to the age of the monkey, with young monkeys showing a later time of onset but a higher level of myopia development.
5. The refractive distribution of the monkey population parallels that of human populations.
6. The level of illumination within the restricted space hoods appeared to be related to the amount of myopia developed.
7. Heredity contributed very little to the simple type of myopia developed by monkeys.
8. The development of myopia in monkeys is related to the accommodative process since the use of atropine appears to arrest its development (*44*).

Conclusion

The review of the literature searched for the answer to the question, "When should children be taught to read?" (Holmes, *18*). The earliest age at which children can learn to read was determined first. This age was established to be younger than the age of six; children could be taught to "read" much earlier than this, even at two years, if certain conditions for learning to read were fulfilled. Whether this updating was desirable, however, was discussed in terms of giving the child a curricular sequence that would be a solid foundation of first-hand experiences upon which he could build his understandings of what he read—partly a matter of educational philosophy, as was pointed out.

Having established a sort of "basal" age at which reading can be taught, several questions immediately arose: 1) What is the most economic age to teach children to read? 2) What is the most natural age in terms of their personal interest and needs? 3) Could other subjects be taught more profitably at the preschool ages, etc.? and 4) Will teaching children to read before the age of six contribute to an advance in the rate at which so-called "school myopia" takes place?

That is, when one submits young and immature eyes to the strain of the close work involved in reading, from the age of 2 to 5 years, what risk is run of permanently damaging eyes? Must one expect such "forced-fed readers" to develop into severe cases of myopes? Will they all have to wear thick, concave glasses in later life? Apparently, the answer is a carefully qualified no at least down to the age of four, for there seems to be very little scientific evidence to substantiate the "use and abuse" theory of myopia after the age of four. While research with human beings accumulates to give greater and greater credence to the heredity theory, (Hirsch and Wick, *13*), animal experimentation appears to offer substantial research for both sides (*20, 44*).

However, a new and unexpected optical risk is revealed in this review. Hirsch (*12*) and Young (*43*) found that refraction is skewed toward the hyperopic side until the age of 9 or 10, is symmetrical at this age, and then becomes increasingly skewed toward the myopic side with increasing age. Since it is a well-known fact that children with uncorrected hyperopia have much more trouble concentrating on the printed page than do normal or myopic children and since learning to read calls for a high degree of concentration, one must also ask this question: Is one not inviting behavioral troubles (from nervous fatigue) if, in impatience to make precocious readers of all children, one indiscriminately teaches all very young children to read at the age of four years or earlier? Furthermore, the eyes are growing at their fastest rate in the first three years, and none of the studies to date indicate what damage may be expected in those formative years by forcing the child to read. Obviously, a great deal more specific information and research are needed.

In short, any researcher who embarks upon a large-scale program involving the teaching of reading to very young children is duty bound to collect comprehensive optometric data as one of the important facets of his study and have each child pass the Modified Clinical Test (*3, 42*) before he begins to learn to read. This requirement is important because there is little experimental evidence dealing with changes in children's eyes between the ages of two and five years of age with or without the imposition of the task of learning to read.

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NEUROLOGICAL AND PSYCHOLOGICAL ASPECTS OF READING

Neurological and Psychological Influence on Reading

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TO SOMEONE who has been, for many years, actively involved in the study of the innumerable factors which influence the reading process, the professional shifts of opinion become alternately significant, amusing, and dismaying. About ten years ago, the so-called personality specialists held the upper hand. Those in the reading field were besieged by opinion and "research" which purported the tremendous importance of psychogenic factors in determining how well a child would learn to read and the significance of these factors in the etiology of reading disability. There was absolutely nothing in the way of personality dynamics which could not in some way be associated with the child's failure to learn. Thus, such concepts as difficulty in handling aggressive drives, fear of looking, appeasement of guilt, and faulty identification mechanisms held sway. It is no wonder that all too frequently the teacher, herself, "gave up" and would rationalize her own failures, and perhaps incompetence, behind the screen of the child's "emotional conflicts."

Then the pendulum shifted, and how it shifted! Slowly, but inexorably, like a sleeping dragon that had been awakened, the basically amorphous but powerful concept of "organicity" reared its ugly head. Quickly one was enveloped by such terms as *minimal cerebral dysfunction, minimal brain damage, dyslexia, maturational lag, developmental discrepancy*, and, the most flowery of all, *cerebral dys-synchronization syndrome*. Now the teacher was not only confused but also found herself in the ranks of the medically sophisticated! The result was almost [illegible]itable. Again the classroom teacher, the reading diagnostician, and the psychologist had found a ready-made wastepaper basket into which those youngsters who were experiencing severe reading disabilities could readily be discarded. Suddenly the incidence of brain damage or delay in maturation of important functions increased sharply.

What is the answer to this dilemma? Are the specialists in each field forever restricted to viewing the problem of reading disability through their own window of specialization? How can the classroom teacher be expected to reconcile these controversial and often contradictory views from the very "experts" who are supposed to be offering them clarification of issues?

The strides which have been made in medicine, psychiatry, psychology, neurology, and education should contribute greatly to the understanding of learning, in general, and reading, more specifically. One must learn to utilize his newly-acquired information more objectively, to fit it into some form of dynamic conceptual framework, and, most important of all, to apply that knowledge always to the "whole child."

The concept of the "whole child" is one which all are inclined to accept, so much so that is has almost become a cliché. Yet at times it appears that one gives lip service to this concept without truly being cognizant of all its ramifications. One should never forget that the child is a physical organism functioning in a social environment in a psychological manner. Reading, being a complex process, may involve any or all of these aspects, with cause and effect being closely interwoven. It is not justifiable, then, to think of the child as an "organic case" or as an "emotional case" or even as one with a "developmental lag." In every child there is always some interaction of functional and organic factors; if one is truly to be concerned with the "whole child," one should be alerted to the multiplicity of factors operating on that child. Even more important, attention should be focused on the coping ability of that child in the learning situation. In the last analysis, the classroom teacher must deal with the child as she sees him. It is certainly true that the teacher should be aware of the many psychological influences on the child, but it is *not* necessary for the teacher to be given an ultimate diagnosis of the child. The teacher should have a clear description of the child's functioning, his strengths and his weaknesses, his coping techniques, and, most important of all, what might be most effective in *teaching* him.

With this information the good teacher should then have the "freedom to fail!" That is, she should have this knowledge on her side, but not be so restricted or afraid of it that she is bogged down by a fear of doing irreparable harm by attempting different procedures with the youngster. For example, an experienced teacher at the Institute for Learning was asked when she would use a kinesthetic procedure with a child. Without hesitation, she replied that she would initially begin with this method. Her major criterion was whether the child accepted this method, seemed comfortable with it, and demonstrated success. Although this teacher had a tremendous amount of information regarding this child's neurological and psychological status, it is important here, in the last analysis, that her real focus of attention was on his anxiety level.

One way to avoid the organicity-environment controversy and to allow the teacher to focus on the "whole child" is to center attention on the ego functioning of the youngster. The very basic functions of the developing personality are referred to as the functions of the developing ego. The ego, in a sense, is a hypothetical construct allowing one to deal with the interaction of functional and organic factors in a dynamic manner. The ego is really synonomous with the "whole child"; all of the ego's functions play a crucial role in the individual's adaptations to the learning situation. When one talks about the ego, he is talking about both the neurological and psychological child, each aspect being inextricably interwoven with the other. Thus the ego's functions include perception, memory, concept formation, motility, cognition, thinking, integration, association, language formation, postponement of gratification, reality testing, and synthesis. These are not just neurological or psychological concepts: they are both influenced by and influencing each other. In short, the ego *is* the child, a physical entity, interacting with his environment and his own ideas and feelings. Anything which interferes with the development of the ego and any of its functions will undoubtedly influence the child's ability to learn to read.

Disturbances in the organic substratum of the ego— the central nervous system

When a child has suffered actual brain damage either prenatally, perinatally, or postnatally, it means simply that he is born with a defect in the very matrix of the crucial organ of learning, the brain, and its sensory and motor systems. Since the foundation of the ego is the central nervous system, there are immediately two strikes against this person's development of normal ego functions. In other words, the defect to the central nervous system makes it extremely difficult for the child to develop, through growth and experience, the primary apparatuses of the ego; namely, such basic skills as perception, concept formation, and language. These deficiencies, in turn, interfere with the child's ability to interact with his environment in an adaptive manner, and, for that matter, for the environment to perceive him in the normal fashion. Thus, as he grows older and there is subsequent disruption to later ego functions, he develops a sense of impotence and of being someone who "cannot" rather than someone who "can." In a very real sense, this child is defeated before he ever starts school. He *feels* so defective and inadequate that even the slightest challenge appears quite overwhelming to him. Furthermore, he senses that he is a disappointment to his parents, particularly to the mother who almost inevitably must respond differently to him than she would to a normal offspring, the wished-for extension of herself. If, as part of the total syndrome, motility is inadequate, the child is further robbed of the gratification of mastering new functions, a situation which then interferes even more with the development of a sense of self-esteem.

It is not at all unusual for a child with this early deficiency in ego development to make some form of minimal adjustment to a kindergarten situation where the demands imposed on him are not too severe. However, his entrance into the first grade, where even mild academic standards are imposed, may change the picture radically. This situation may be the first in which the deficient ego functions are found. The child now begins to show many of the symptoms which are usually associated with brain damage. He is hyperdistractible, hyperactive, and disinhibited; he shows a considerable degree of impulsiveness. The defect in his ego mechanism does not give him the capacity to inhibit or redirect his impulses or to develop social control of them. He is driven to such behavior as boisterous talking, shouts, uncontrolled laughter, and striking other children. He is highly narcissistic and evidences what aptly could be described as "dependent despotism." Because of the high degree of narcissism, he is extremely hostile. The hostility also represents the narcissistic attempt to control—the meaning of dependent despotism.

However, all of these symptoms must, at all times, be related to the deficiencies in normal ego development. It has never been proved that hyperactivity or distractibility are related to defective neural transmission or specific brain cell malfunction. All of the foregoing symptoms represent the ego's method of defending the rest of the personality from awareness of its defects. Thus, the role of the teacher, particularly the first grade teacher, becomes of great significance in determining the degree to which the child will be crippled by the interference to the development of ego functions. Many children begin school with so-called cerebral dysfunction but never evidence the usual symptoms associated with this category simply because of the kind of interpersonal relationship established between the teacher and child. This relationship can go a long way to foster ego development and compensate for some of the traumatic influences having occurred earlier.

Sometimes the brain-damaged child gets by in the earliest grades through his capacity for rote memory work in arithmetic and spelling. A large percent of these youngsters do not exhibit word recognition difficulties *per se.* Many of them are able to "read" words quite well. Even a cursory check of their understanding of selections reveals that they are seriously handicapped because of their inability to engage in active mental manipulation, to see relationships, and to do real conceptual thinking. On intelligence measures, most characteristically, this kind of child will achieve much higher scores on verbal than on nonverbal tests. An analysis of his responses reveals again that the deficiency in the nonverbal area is attributable to the basic deficiency in ego functions. Whenever the child must actively involve himself in a situation and attempt to manipulate a problem to a successful solution, he experiences difficulty. All in all, it is most essential to keep in mind that he is crippled not because of the damaged neural tissue but rather because of the lack of development of specific ego functions at the time they would ordinarily have developed. Thus, any effort on the part of the teacher to foster ego development may have beneficial results.

Maturational and development disturbances

Assuming that the basic organic endowment is adequate, disturbances can arise from some interference with or delay in the maturation or development of the apparatus and its functions, which are necessary for formal academic learning. Certainly there are some children who, for one reason or another, are not prepared for formal learning at the usual age in our culture. It must be emphasized that just because a neurological or biological difficulty exists in a child, it does not necessarily indicate that the child will develop a serious learning problem. It may very well be that in order for a youngster to develop into a so-called remedial type case, he must have this predisposition; but simply because the tendency is present, it does not mean that he *must* develop the disorder.

Most teachers today recognize the fact that some children are maturationally unprepared for learning to read when they are first introduced to the printed symbol. A small percent of these children may not have fully mastered certain ego functions which are basic to reading. These functions include perception, concept formation, and, specifically in the reading area, associative learning ability. This kind of child experiences real difficulty in the association of common experiences and the symbols (words) which represent them. Since reading, in the last analysis, is a process of association, difficulty in this area presents a major problem for this student. He tends to have less difficulty in association when both the visual and auditory sensory pathways are involved as compared to the making of strictly visual associations. In other words, he is better able to associate when he is using both the visual and auditory sensory mechanisms. He also often shows a disturbance in concept formation and abstract function. He evidences definite interferences in memory span. As opposed to many neurotic children who also evidence interference in attention span, the remedial child does not have the ability to summon up the resources within himself to force attention; that is, he cannot concentrate.

When this child is initiated into reading at a time when his ego deficiencies do not allow him to profit from the normal methods of teaching reading, he almost inevitably experiences failure. It is no wonder that a secondary emotional problem may then ensue with great discouragement on the part of the child and a negative attitude toward reading.

This negative attitude may account for many of the symptoms which are associated with the remedial child. It is no mere coincidence that this kind of child has difficulty with concentration in dealing with only wordlike or school-like material. The memory span of these children, when dealing with visual objects rather than letters, is quite superior. Their ability to make visual-visual associations is more than adequate when the stimuli are geometric rather than wordlike. It is true that they most characteristically show superior achievement on the nonverbal area of an intelligence test as compared to their achievement on the verbal area. Nevertheless, an analysis of their responses indicates that their poor performance in the verbal area is directly attributable to inability to concentrate on abstract stimuli. Concentration on concrete stimuli is superior even to achieving readers.

Implications for education

The implications of the foregoing to the classroom teacher are quite evident. If the child can be "picked up" before the negative attitude toward reading develops, a great deal of trouble will be avoided. Unfortunately, surefire devices and techniques to recognize the remedial child do not yet exist until he demonstrates the symptoms which represent adverse attitudes. Thus, the teacher is often left with the responsibility of attempting certain techniques which may, artificially at least, help the child to concentrate. Certain reinforcement techniques to aid word recognition, such as the kinesthetic approach, may be helpful and important especially in the early stages of working with the remedial child. These techniques often work probably not because of teaching other areas of the brain to take over the function of the damaged area, as has often been suggested, but because the techniques aid in the development of more adequate ego functioning. As the child is given a new technique for the recognition of words, he begins to develop a greater degree of confidence in himself. With this increased confidence, there is less refusal of tasks, and fewer evasive devices are used as the child's narcissism is not so threatened as it was before.

Conclusion

In this brief discussion the remarks on ego functioning and learning have been limited to two areas of difficulty. Much could be written about current environmental disturbances or the ego's reactions to adverse influences from the outer world. A holistic approach must be taken to the understanding of the child in serious reading difficulty. An understanding of the nature of ego functioning and its effect on learning ability and coping behavior gives the teacher specific clues as to how he should handle this type child in the classroom. If the "whole child" is constantly kept in mind, if one does not become lost in a myriad of conflicting terminology and conceptual orientations, and if one has the freedom to use experience and intuition to try even controversial approaches, then a better understanding of all of the neurological and psychological influences involved will be had.

Neurological Research Relevant to Reading

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AN IMPORTANT AREA of interest to teachers, pediatricians, and neurologists is that of neurological growth and development.

The failure to establish preferential use of eye or hand, or establishment of preferred eye and hand on opposite sides of the body, has been considered evidence of incomplete or mixed cerebral dominance and implicated as causally related to reading disability by some authors. Studies by Belmont and Birch (*2*) have shown that the establishment of laterality preference is a function of age. Incidentally, this preference may change from side-to-side in early years and not be complete until age 11 or 12. Of course, in some adults with no reading problem, it may never be established. The background of establishment of laterality preference as a function of age must be present in order to assess significance of laterality preference, or its lack, in a given child with reading disability.

Belmont and Birch (*2*), Rosenberger (*19*), and Silver and Hagin (*21*) failed to find a significant increase in the incidence of incomplete or crossed laterality preference in poor, as opposed to good, readers.

Laterality awareness—the ability to identify correctly right and left on one's body, on another person, or in extracorporeal space—is also a developmental phenomenon. These several subfunctions first appear in most normal children at fairly closely defined age ranges. Birch and Belmont (*2*) and others have indicated the ages at which these various subfunctions "mature" in normal children. In general, recognition of right and left on one's own body is seen in most children around the middle of the first decade of life, and ability to perform the most difficult task—right and left ordering of several objects in extracorporeal space—is accomplished late in the first, or early in the second, decade of life. Birch and Belmont (*2*) and Rosenberger (*19*) find that there is a significantly increased incidence of defective laterality awareness in poor readers.

In interesting contrast, Alexander and Money (*1*) find in patients with Turner's syndrome a cytogenetic disorder with disordered development of primary and secondary sex characteristics, deficit of form perception and of directional sense, and essentially normal reading skill.

Another area showing developmental change with age is that of associated movements in one hand which mimic those of the other hand performing a task—so called mirror movements. Normal patterns of development presented by Fog (*6*) of Denmark show that 90 percent of five- to six-year-old and 10 percent of fourteen- to sixteen-year old normal children exhibit such movements. The frequency of occurrence is influenced by the emotional and physical state of the children and the nature and relative difficulty of task.

Another kind of movement which has attracted attention is that of choreiform movements, which when coupled with reading disability have been termed the *choreiform syndrome* by Prechtl and Stemmer (*18*).

Stemmer (*23*) by herself, and Rutter, Graham and Birch (*20*), in more recent years, have studied larger numbers of children with and without reading disability and find no significant association between choreiform movements and reading disability.

Another group with prominent motor signs are those described by Gubbay, Ellis, Walton, and Court (*9*). They described a curious group of children with a high incidence of left-handedness, right-left disorientation, crossed laterality, poor handwriting, speech defects, constructional apraxia, squint, abnormal electroencephalogram, inability to dress self even in second decade of life, and other findings sometimes considered indicative of central nervous system pathology and significantly associated with reading disability. Of interest is the fact that some of these children had no difficulty with reading and only six of the twenty-one patients reported had serious reading disability.

Cerebral dominance

The concept of cerebral dominance and of disturbances of it has been considered by some to be importantly related to reading disability. Over many years observations on this problem have been made at the Montreal Neurological Institute. Some of these observations have been recently sumarized by Milner *et al* (*17*).

The individuals studied and upon whom the observations have been made are those who have a focal seizure disorder which is presumed, after extensive neurological evaluation, to be susceptible to surgical treatment. An important feature of this evaluation is the determination of the cerebral hemisphere dominant for speech. To this end, the Wada test is performed. This test consists of the injection of sodium amytal into, first, one carotid artery and then the other. The purpose of the test is to determine whether the injection of amytal is followed by transient aphasia. The injection of amytal into the carotid artery supplying the speech-dominant side will produce the transient, but profound, loss of speech. In assessing the results obtained with this procedure, it is important to realize that this is a highly selective population. Each individual in it already has a clearly established expression of central nervous system disfunction, namely, a seizure disorder.

The speech center was on the left side of the brain in 90 percent and in the right side in 10 percent of right-handed individuals. There was no bilateral representation of speech in right-handed individuals.

The assessment of the Wada test in left-handed or ambidextrous individuals must take into account whether or not there is a history of early brain damage. The speech center was located on the left side of the brain in 64 percent, on the right in 20 percent, and bilaterally represented in 16 percent of left-handed or ambidextrous individals with no history of early brain damage. Speech was on the right side of the brain in 67 percent, on the left side in 22 percent, and was bilaterally represented in 11 percent of left-handed or ambidextrous individuals with a history of early brain damage.

These observations confirm the hypothesis derived from clinical observation that the cerebral organization of language is less predictable in a left-handed or ambidextrous individual than in a right-handed one. In ten instances with bilateral representation of speech none were right-handed. This finding lends support to the notion that individuals with left-handed tendencies show less clearly cut unilateral hemispheric localization of language than do right-handed individuals.

These observations are, to a degree, to be expected in the light of knowledge of cerebral function and language vocalization. Of particular interest to educators, especially in the light of the emphasis upon so-called brain damage and its effect upon speech localization and one's concept of laterality, is the observation that in individuals with a history of unequivocal left-brain injury, speech may still reside in the left side of the brain and has not been transferred to the opposite side of the brain.

Related observations were reached by Efron (*5*), who examined the hypothesis that temporal discrimination is made in the hemisphere dominant for speech. His observations support, but do not establish, this hypothesis. The results of his experiments suggest that conscious comparison of the time of occurrence of two sensory stimuli (closely related in time) require the use of the hemisphere dominant for language. Sensory messages which carry information as to time of occurrence and are received by the non-dominant hemisphere are transferred to the dominant hemisphere over a longer pathway than the one directly to the dominant hemisphere.

The hemisphere dominant for comparison of time of occurrence is the left in almost all right-handed and most left-handed adults. The right hemisphere is dominant in this sense for a few left-handed people.

This study, and one with aphasic adults (*4*), suggests that "much of the consignment of higher functions to the dominant hemisphere will be discarded with recognition that regardless of where the actual centers are located, many functions will appear to be in the dominant hemisphere simply because, to become conscious, the phenomena must submit to this hemisphere's 'temporal analysis.' "

Kimura has suggested that the ear opposite the hemisphere dominant for speech is the better, or more efficient, ear for hearing verbal material (*10, 11*); the ear on the same side as the hemisphere dominant for speech is more efficient in recognizing snatches of melody (*12*).

These citations illustrate that "cerebral dominance" is as "cerebral dominance" does. They do not directly relate reading disability to cerebral dominance but indicate its complexity and clearly indicate the need for caution in any explanation of reading disability which oversimplifies the concept of cerebral dominance.

Silver and Hagin (*21*) are currently utilizing Schilder's extension test as a primary measure of cerebral dominance. This test consists of asking the child to extend his arms, with fingers spread, while his eyes are closed. Usually one hand tends to be slightly higher than the other. The higher hand corresponds to the hand used for writing. If the hand opposite the hand used for writing is higher or if both hands are held at the same level, the test result is considered abnormal. They found that 90 percent of children with reading disability have either relative elevation of the arm opposite that used for writing or relative elevation of neither arm. Conversely, 95 percent of children who have an abnormal extension test have a reading disability. This is an interesting observation using an amazingly simple clinical tool. It will prove of great value in diagnosis if the findings are replicated by others.

"Split-brain" syndrome

Another avenue offering insight into the nature of cerebral dominance is that of the so-called "split brain" syndrome. The writings of Gazzaniga, Bogen and Sperry (*7, 22*) and Geschwind (*8*) are particularly valuable. In brief, the individuals studied were those in whom anatomical connections between the two cerebral hemispheres have been surgically interrupted. Obviously, these are individuals with some medical disorder which resulted in the surgery and are, therefore, not an unselected population.

The number of human beings available for study is necessarily limited; but the results suggest that performances in which the visual inflow was to one hemisphere only, the required response involving only the hand controlled by the hemisphere, were little affected. Responses requiring interaction or direct cooperation between the two hemispheres are seriously disrupted.

Activities involving speech and writing were well preserved to the extent that they could be governed from the left hemisphere. It was clear that visual information was not transferred from one hemisphere to the other.

Gazzaniga *et al* (*7*) concluded that localization of other functions in the human cerebral cortex can be tentatively located, as follows:

In the minor (usually right) hemisphere:

1. Conception of extra-personal spatial relations
2. Recognition of faces
3. Hearing nonverbal sounds; i.e., clicks or music
4. Performance of block design test
5. May be able to match and comprehend written with spoken words, using only this hemisphere.

In the major (usually left) hemisphere: match (but not reproduce) patterns of blocks.

Investigators at the Veteran's Administration Hospital (*3*) in Boston suggest that lateral specialization may lie more in motor or executive than the sensory-perceptual component of performance.

Sequencing

The term refers to the serial order or spatio-temporal array of letters in words and words in a sentence.

Le Cours and Twitchell (*15*) presented conclusions drawn from the analysis of spelling errors in intelligent and educated adults with reading disability. A high percent of the errors were attributed "to one or several of the following mechanisms: 1) addition: for example, several becomes serveral; 2) deletion: for example, elderly becomes eldery; 3) substitution, for example, midnight becomes mignight and 4) inversion: for example, presence becomes presenec." Le Cours (*14*) suggested that the phonetic structure of words can occasionally reinforce these errors and that a common denominator in all four types of errors is the presence of pairs of identical letters in a word.

MacNeilage (*16*) reached a similar conclusion in analysis of typing errors. He postulated that one of the determinants of language output is a "programing mechanism" which determines the order of units, that which will be an integrated sequence and that which will not be. It is speculated that "the programer activates, to varying degrees, a number of units stretching some distance ahead of the current response in time." The programer can be "confused" by the occurrence of two identical commands at about the same time; i.e., identical letters in a word. The programer displaces or postpones one of the commands, producing a spelling error.

Rosenberger (*19*) concluded that inability to place letters in proper sequence in words is of major significance in poor reading. This is a distinction other than the inability to recognize the individual letters in a word or inability to learn the "meaning" of a word.

Kolers and Katzman (*13*) reached similar conclusions from analysis of some individuals' responses to identification of letters in certain words. The letters were presented, tachistoscopically, in serial order corresponding to the left-to-right sequence in which they occur when the particular word is written. The authors suggest that there is an "ordering operator" (MacNeilage's "programing mechanism"?) in the visual perceptual system which is aware of the temporal array of letters in a word before each member of the array is correctly identified. That is, the number of letters in a word is correctly counted but the placement of one or more letters, in left-to-right sequence, may be incorrect.

In summary, two areas of developmental neurology and two of, perhaps, broader application have been presented. The former two areas indicate clearly that 1) assessment of a given child's neurological development must take account of the extraordinary variation in rate and degree of development of functions germane to reading achievement; and 2) the significance of presumably abnormal neurological signs found in a child with reading disability must be compared with their frequency of occurrence in a normal or unselected population of age-peers. The latter areas indicate 1) the complexity of the concept of cerebral dominance is currently probably most accurately defined in operational terms and may implement understanding of reading disability; and 2) the concept of "sequencing" or spatio-temporal organization of language input and output is in an interesting stage of development and may contribute to understanding of reading, ordered or disordered.

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A Clinic Team Approach to Reading Problems: Role of the Neurologist

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IN THE PAST FEW YEARS many leading neurologists have become increasingly aware of the responsibilities of neurology in the entire field of learning disorders (*26*). Particular concern has been shown toward the problem of specific language disabilities—developmental dyslexia and related conditions (*14*).

These specific language disabilities have a high potential salvage rate, depending on early recognition and proper use of known remedial techniques (*34*). Conversely, it is increasingly clear that inadequate educational and medical attention to these problems nearly always has tragic personal and socioeconomic implications (*12*).

Historical background

The first article in medical literature dealing with a specific reading disability appeared in the *British Medical Journal* (*28*) in 1896 by Morgan, a general practitioner, who wrote:

> Percy F.,—a well-grown lad, aged 14—is the eldest son of intelligent parents, the second child of a family of seven. He has always been a bright and intelligent boy, quick at games and in no way inferior to others of his age.
>
> His greatest difficulty has been—and is now—his inability to learn to read. This inability is remarkable, and so pronounced, that I have no doubt it is due to some congenital defect.
>
> He has been at school or under tutors since he was 7 years old, and the greatest efforts have been made to teach him to read, but in spite of this laborious and persistent training, he can only with difficulty spell out words of one syllable . . .
>
> He seems to have no power of preserving and storing up the visual impression produced by words—hence the words, though seen, have no significance for him. His visual memory for words is defective or absent; which is equivalent to saying that he is what Kussmaul has termed 'word blind' . . .
>
> Cases of word blindness are always interesting, and this case is, I think, particularly so. It is unique, so far as I know, in that it follows no injury or illness, but is evidently congenital, and due most probably to defective development of that region of the brain, disease of which in adults produces practically the same symptoms—that is, the left angular gyrus.
>
> I may add that the boy is bright and of average intelligence in conversation. His eyes are normal, there is no hemianopsia, and his eyesight is good. The schoolmaster who has taught him for some years says that he would be the smartest lad in the school if the instruction were entirely oral. It will be interesting to see what effect further training will have on his condition.

In 1917 Hinshelwood, a Scotch ophthalmologist, published the first monograph on *Congenital Word Blindness* (*21*), reviewing his personal series of 31 cases which he had collected over a period of nearly twenty years. Hinshelwood apparently regarded this as a relatively uncommon hereditary condition, which he defined as "a congenital defect occurring in children with otherwise normal and undamaged brains, characterized by a difficulty in learning to read so great that it is manifestly due to a pathological condition and where the attempts to teach the child by ordinary methods have completely failed" (*21:40*).

The first neurologist to make a long and careful study of this and related disorders was an American, Samuel T. Orton. His classic monograph, *Reading, Writing, and Speech Problems in Children* (*30*), first published in 1937, is still in print, due to the efforts of the Orton Society.

Orton emphasized the relationship of reading disability to other developmental language disorders, such as congenital dyspraxia or clumsiness, mirror writing, severe spelling difficulties, and ambiguous or confused handedness. Unfortunately, his views on the role of cerebral dominance have been subjected to considerable misinterpretation and distortion. Many of Orton's concepts and formulations have only recently, after 30 years of relative neglect, come into recognition as providing a solid foundation for the diagnosis and treatment of these cases.

Following Orton's work many neurologists, as well as workers in other disciplines, have contributed to a better understanding of the specific language disabilities. In this country, Schilder (*35*) and Bender (*1*) drew attention to the disturbance in gestalt function in developmental dyslexia and the concept of an accompanying lag in cerebral maturation, which may result either from hereditary factors or acquired cerebral dysfunction.

The important contributions by Scandinavian workers should be noted, particularly those of Skydsgaard (*37*), Hallgren (*19*), and Hermann (*20*), who made extensive clinical studies of hereditary factors in dyslexia. The studies of Kawi and Pasamanick (*22*) in the United States have shown the important role of complications of pregnancy, birth, and early postnatal life in the later development of reading disability as "a component in the continuum of reproductive casualty."

During the past few years considerable attention has been given to the development of more refined techniques for neurologic examination of children. Several recent studies, such as those of Cohn (*7*), Clemmens (*5*), Clements and Peters (*6*), and Silver and Hagin (*36*) have described various equivocal or "soft" neurological signs which may be of diagnostic value in a more detailed or expanded neurologic examination than is usually carried out. The recent availability in English of the multiphasic studies of higher cortical functions by Luria (*25*), the Russian neuropsychologist, has provided additional material which may broaden the scope of the clinical examination.

At a number of research centers work has been in progress in the attempt to standardize some of these equivocal techniques. Of particular value have been the studies of Fog and Fog (*13*) on abnormal associated movements, Walton and his colleagues (*38, 18*) on the clumsy child, Bergès and Lézine (*3*) on the imitation of gestures, Kinsbourne and Warrington (*23, 24*) on finger agnosia, and Paine (*31*) on minor or borderline cerebral palsy syndromes.

The concept of "minimal cerebral dysfunction" has had wide acceptance as a useful neurological diagnostic label for a variety of these conditions, although the vagueness and lack of specificity of this term are objectionable. There is lack of general agreement on a definition and on suitable criteria for diagnosis.

Critchley, formerly dean of the Neurological Institute of London and now president of the World Federation of Neurology, recently published his monograph, *Developmental Dyslexia* (*8*), which summarizes the development of a substantial body of knowledge on the neurological aspects of reading disabilities of children. Critchley's earlier delineation of the functions of the parietal lobes (*9*) paved the way for more detailed studies of these problems in children and provided a strong stimulus for the expansion of techniques of the clinical neurological examination.

Interdisciplinary team concept

The pioneer, comprehensive interdisciplinary study by Rabinovitch and his colleagues (*33*) at the University of Michigan Medical Center provided a practical classification for reading disorders: 1) those with frank brain damage; 2) those with a subclinical neurologic deficit (primary reading retardation); and 3) those with normal reading potential but with personality or educational handicaps (secondary reading retardation).

Since the report of this study by the Michigan group to the Association for

Research in Nervous and Mental Disease in 1954, appreciation of the value of the team approach for the diagnostic study and for the formulation of a treatment program for individual cases has increased. The development of interdisciplinary teams in a number of medical centers has, in turn, stimulated the growing interest in medical research in this field. The team concept has emphasized to the neurologist and the psychiatrist the importance of utilizing the information obtained by specialists in other medical and paramedical fields for a complete evaluation of the functions of the nervous system in children with language disorders.

Cerebral localization and dominance

According to current concepts, reading disability must have, as a minimal substrate, a bilateral dysfunction or maldevelopment of the parieto-occipital region, particularly the angular gyrus. Critchley (*10*) pointed out that these children usually show signs which indicate a state of cerebral ambilaterality, implying, at least, a certain lack of maturation.

Geschwind (*15*), director of the Aphasia Research Center in Boston, recently reviewed the various known cerebral disconnection syndromes. He reemphasized the importance of weak or faulty subcortical connecting pathways, as opposed to isolated, more purely cortical lesions in the pathogenesis of congenital as well as acquired disorders of language.

The exact role of poorly established or confused cerebral dominance in dyslexia is still being debated (*29, 2*). The failure to establish a clearly dominant hemisphere, as reflected by handedness, is rather obviously the result and not the cause of congenital abnormalities of cerebral dysfunction which also express themselves in language disabilities.

Goodglass and Quadfasel (*17*) and others have demonstrated that the majority of people, in the course of learning to speak, establish their speech center in the left cerebral hemisphere, to some extent independently of whether they are right or left-handed.

As Brain (*4*) pointed out, several different nonlinguistic functions, which are also important to learning—such as awareness of space, body image, ease of calculation, and capacity to carry out purposive movement—appear to behave independently of one another in relation to hemisphere dominance. The left may be the major hemisphere for some of these functions and right, for other functions, both in normal individuals and in those handicapped by a language disorder.

Role of the neurologist

The neurologist occupies a unique position on the interdisciplinary team. His detailed knowledge of the structure and functions of the nervous system makes it possible for him to integrate his findings with those of the other medical and paramedical members of the team whose examination techniques provide specialized extensions of the classic neurologic examination.

The neurologist should assist the educator and the primary physician, usually a general practitioner or pediatrician, in the formulation of an individualized treatment program which may include recommendations for psychotherapy, drugs, and physical and occupational therapy as well as a remedial teaching program (*16*).

A profile of the child's sensory, motor, and perceptual capacities will indicate which input systems are most intact and available for learning, as well as the weak functions which need support and development. The overemphasis on a single remedial technique, such as the exclusive use of a phonetic or kinesthetic method, is to be deplored because of the potential emotional damage to children whose perceptual defects make the particular approach inappropriate (*27*). Any method which may put an excessive burden on an individual child's weakest input channel is clearly unsound.

From the neurological standpoint, every type of standard therapy which may improve the child's total functioning, including his self-image, should be considered in planning an individual treatment program. A variety of valuable therapeutic aids may be obtained from occupational therapists, such as devices which promote the development of finger sensory and motor skills and improved eye-hand coordination. Physical therapists also may provide useful techniques for the improvement of rhythm, speed, and fluency of movement.

Many younger children with poor motor coordination or perceptual dysfunction would be greatly helped by better organized developmental reading- and writing-readiness programs. Another generally neglected but potentially highly valuable type of ancillary approach is that of remedial physical education. Unfortunately, most public school programs do not provide adequate special facilities or attention for the more remediable borderline cases, although more intensive help may be available for those with obvious physical handicaps.

Various current faddist approaches (*27*) which attempt to affect or alter cerebral dominance, or to place heavy emphasis on orthoptic exercises, or to utilize regressive motor techniques for sensorimotor patterning, such as creeping and crawling, should generally be avoided. These techniques, purportedly based on concepts of neurological function, generally fail to consider fully the complexity of cerebral organization involved in language. While any treatment which holds promise may be of some apparent value because of a placebo effect or the total push aspects of a more complicated program, these approaches may also be disastrous for other children and their families because of the loss of valuable time and the psychological and financial burden of an additional failure.

In general, drugs have only a limited place in the treatment of children with reading disabilities (*39*). In the majority of cases drugs probably ld not be recommended. How-, in children with occult, subclinical convulsive seizures the proper use of anticonvulsant medications, such as phenobarbital, diphenylhydantoin (Dilantin), and primidone (Mysoline), may be instrumental in allowing the child to show progress in school.

A frequently encountered indication for drug therapy is the hyperkinetic behavior disorder which often accompanies and aggravates developmental dyslexia. The hyperkinetic behavior syndrome is characterized by general motor overactivity, short attention span, low tolerance for frustration, emotional liability, and cyclic variations in behavior. Markedly hyperkinetic children may require some effective drug therapy before they can properly participate in a remedial reading program.

The most effective drugs for hyperkinetic behavior are the cerebral stimulant drugs, which often have a paradoxical calming action in this condition. The amphetamines, methylphenidate (Ritalin), and deanol (Deaner) have been found to be highly effective in a majority of cases (*11, 32*). Unfortunately, however, there are a few cases in which these drugs fail to help.

In the management of more severely disturbed cases of hyperkinetic behavior several of the phenothiazine group of major tranquilizers have been useful, particularly chlorpromazine (Thorazine), trifluoperazine (Stelazine), and fluphenazine (Prolixin, Permitil). Other drugs which have been used successfully for milder cases include diphenhydramine (Benadryl) and hydroxyzine (Atarax, Vistaril), both minor tranquilizers with antihistamine activity.

Although they are occasionally useful, the ordinary barbiturate sedatives —such as phenobarbital, and mild tranquilizers with related activity, such as meprobamate (Miltown, Equanil)— often have an undesirable excitatory effect and may actually aggravate hyperkinetic behavior.

The neurologist should be a continuing participant in the management of a treatment program involving the use of drugs. He should also be available for consultation when basic changes are being planned for the other aspects of a remedial program.

There has been a regrettable tendency among some members of the medical profession to an attitude of isolationism toward members of other professions, including educators. On the other hand, a similar undesirable defect in capacity for free communication exists in some members of the teaching profession. The urgency of the need to break down these barriers between the professions is clear.

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Reading—a Product of Sensory Integrative Processes

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THE ABILITY to learn to read is a highly complex function of the central nervous system. That function is not isolated from other neural processes; on the contrary, it is not only connected with but also is dependent upon action in many parts of the brain. Every higher cognitive process involving the cerebral cortex of man is dependent initially and ultimately upon less complex functions involving lower neural structures. As one of the higher cognitive functions, reading has some of its foundations in sensory integration. It is proposed that some types of reading disability can be understood in terms of disorder of the sensory integrative processes and that formulating the disability in these terms provides a basis for effective treatment of the underlying [illegible]logical dysfunction. One of th[illegible] gaps in knowledge today is [illegible]ween the mass of basic research data in neurology and its application to the child who has difficulty learning to read because his brain is not functioning normally.

The proposed thesis is developed in three steps: 1) The manner in which the operation of the brain is believed to have developed phylogenetically as well as ontogenetically will be discussed at some length, for it is believed that the effectiveness of remedial measures through neurobehavioral methods varies in direct ratio to the clinician's understanding of the neural activity involved. 2) In order to influence sensory integration, there must be some working hypotheses regarding its nature; accordingly, some neural mechanisms are postulated with descriptions of how they are manifested in children and how they might be related to reading disability. 3) Lastly, the principles of remediation which have evolved from the theory are presented, with a few examples of their implementation.

How the brain developed the ability to learn to read

Man's brain has developed over millions of years. Everything that occurred over those years to influence its evolution toward a more effective structure is in some way related to each child's individual development. In turn, each child's ability to master reading, as well as other academic subjects, is dependent upon his development.

Helpful ways of looking at the brain and its capacity to learn as products of evolutionary development have been advanced by neurologists such as Herrick (*6*) and Sherrington (*13*). Both of these scientists, and others as well, have attributed the phyletic origins of the neural structure subserving cognition to the primitive sensorimotor systems.

The sensory impulses which seem to have played a particularly critical role in the evolution of reading ability have been those from the body, i.e., somatosensory, and the vestibular apparatus, which responds to gravity and motion. Both types of sensory receptors are more primal than those for vision and appear to be critical to the phylogenetic and ontogenetic development of visual perception. The visual and auditory developmental contributions to reading skill are more readily apparent. The integration of sensory input cannot be considered separate from the motor activity which elicits most of the sensation, which attributes meaning to it, and which assists in its integration.

Sensorimotor functions of the brain require neural structures for their mediation. As these processes became more complex, additional nervous tissue was required. As each new structure of the brain appeared in the course of evolution, it provided *additional* rather than *substitute* control. It is helpful to think of both phyletic and ontogenetic development as changing in degree of complexity, as well as in kind. At each level of evolutionary development the organism had a sufficiently well-integrated repertory of sensorimotor behavior to enable it to adapt successfully to the environment. Today the cortex is considered the highest structure of man's brain, but it still is dependent upon lower neural structures for adequate performance.

At each level of the central nervous system there are important centers for the regulation of behavior: the lower the level, the more simple and exclusively sensorimotor the function; the higher the level, the more complex the organization and the greater the incorporation of cognitive processes. Luria has presented a lucid account of how any activity in any given cortical area is dependent upon lower neural structures but, simultaneously, also is dependent upon function of the brain as a whole, although not equally dependent upon all other parts. He believes that localization exists to the extent that functional systems are affected differently by lesions in different parts of the cerebral hemispheres. Since reading is one of the most complex of man's skills, Luria's concept of each system of the brain being responsible for different aspects of a unified whole seems particularly pertinent. As he states it, interference with one link of the system affects the end product of the system. Cerebral cortical areas are considered "junctions" in the dynamic systems.

Interpreted in direct relationship to reading disabilities, these concepts suggest that reading requires more than highly integrated activity in a certain area of the cortex; it is, to a certain extent, dependent upon normal function in other cortical and subcortical structures, including the diencephalon and brain stem. The remediation of reading disability might well initially be directed to integration in these lower structures.

Another principle moderating the evolutionary route is intersensory integration: the lower the animal on the phyletic scale, the less the quantity of intersensory integration and the poorer the ability to associate information from one sense with that from another. In the evolutionary process, the capacity for intersensory association increases. Birch and associates (*2, 3*) have directed attention to the importance of this process in individual development. In man, much of the cerebral cortex is composed of areas which integrate information from several sensory sources. Luria (*8*) has pointed out that these areas are topologically located to associate function from two or more nearby cortical loci. For example, the speech area of the cortex evolved topographically next to the sensory area for hearing, the motor area for the lower face, and the somatosensory area of the lower face. The production of speech involves all three sensorimotor functions. However, it also involves other cortical areas, for Luria's work shows that in mature individuals cortical areas outside those usually designated as speech areas may also result in aphasia.

Similarly, Russell (*11*) has proposed that speech mechanisms may not work properly unless in full communication with other parts of the brain, including the alternate hemisphere. He suggests that in order to read, the whole speech territory must be operating; for the foregoing to occur there must be efficient communication between the visual, auditory, and somatosensory systems.

A characteristic of the nervous system upon which the entire past, present, and future evolutionary process is dependent is that of plasticity or adaptability. The capacity to respond to the environmental demands and to make permanent structural changes resulting in altered function has enabled man's development into an organism that can read. It is upon this capacity that the success of a neurobehavioral approach to treatment of learning disabilities rests. The capacity of the young brain's potential for reorganization undergirds the assumption that central nervous system integration is a matter of degree and kind rather than of presence or absence. The assumption is also basic to a neurobehavioral approach to modification of the capacity to learn.

The ability to learn to read, then, is postulated as the end product of a long evolutionary course in which the increased capacity of sensory integration, accompanied by the ability to emit an adaptive motor response, has furnished a critical foundation and is no less essential in the child today. Stated more to the point, a successful motor response to several different types of sensory input is a necessary but not a sufficient condition in the eventual development of the child's capacity to higher academic work. Elementary sensorimotor development, of course, must be followed by more complex visual and auditory processes, language and cognition.

Sensory integrative mechanisms

If the brain does operate on the basis of functional systems which involve many levels and parts of the brain and which are relatively separate but in some way related to one another, what is the implication for reading disability? It is proposed that reading is the function of a system which directly involves several levels of the brain. At this stage of understanding neural organization, the structures whose contributions are most easily observed are the brain stem, diencephalon, and cortex.

Three functional systems involving sensory integration at these levels are postulated to underlie the reading process. They tentatively have been statistically identified (*1*), with further understanding derived from subsequent clinical practice and basic research findings. The absence of reference to language functions in these mechanisms is due to the focus of research and not the lack of belief in the relationship.

Research literature on neural correlates of reading disability frequently points to the involvement of postural mechanisms, including ocular and vestibular connections (cf. *12, 14*), and some mechanism concerned with interhemispheral integration. The pattern of dysfunction seen in children with learning problems is characterized by insufficient inhibition of the primitive tonic neck and labyrinthine reflexes, deficiency of equilibrium reactions, difficulty in moving the eyes across the midline, inability to coordinate simultaneous motor activity on the two sides of the body, and (tentatively proposed) defective visual perception of the horizontal sequence of objects in space.

Just why these conditions interfere with reading is not clear, but it seems worth considering the role of a centrencephalic system as proposed by Penfield (*9*). Findings from basic neurological research are at least consistent with the concept that some system located in the brain stem and diencephalon is responsible for integrating function, including that of the two hemispheres.

Interhemispheral integration is conceivably essential to reading for two reasons. Since the two halves of the visual field of each eye go to the two different hemispheres, interhemispheral integration is required to relate the two halves. While language functions are more highly lateralized than many other sensorimotor processes, they are still believed to be dependent upon both hemispheres (cf. *8, 11*).

The rationale underlying the proposed influence of postural functions is less easily formulated. Since the brain stem is the locale of major integration of many postural processes, it may be that it is in some way connected with the centrencephalic system. A further possibility lies in the intimate connection between the vestibular and ocular systems.

Praxis, or the ability to program a motor act, shows a close relation to reading skill even though reading would appear to be only distantly related to goal-directed movements of the body. Deficits in praxis, apraxia or dyspraxia, are characterized by poor tactile and, less frequently, kinesthetic perception and difficulty in motor planning.

Conjecture as to the basis for association between reading disability and apraxia helps build a working theory to guide treatment. The phylogenetically and ontogenetically most recently developed structures of the brain often serve the most complex functions. The most complex operations of the brain are often the most vulnerable to dysfunction. That portion of the frontal lobes where motor plans are believed to be formed (in connection with subcortical structures) not only represents both of these conditions but also is an area of intersensory integration. Quite similar deductions can be [illegible] about the cortical areas responsi[illegible]r reading. It may be that some type of neural dysfunction tends to affect both praxis and reading as similarly complex acts dependent upon sensory integration. Furthermore, the partial interdependence of different parts of the cortex on each other favors hypothesizing that apraxia in itself influences reading ability.

Probably the most commonly considered and obvious sensory integrative mechanism subserving reading is visual form and space perception. The mechanism, however, quite significantly includes more than visual perception: it covers tactile and kinesthetic perception of form and space as well. The appearance of these three different types of perception in association leads to concluding that intersensory integration is an important element. The work of Held and Hein (*5*) supports the belief that the somatic sensations which are produced during movement contribute importantly to the development of visual perception.

Principles of remediation and examples of procedures

If the three postulated sensory integrative mechanisms are each related to the ultimate process of reading, then remediation of reading disorders might be approached by enhancing the efficiency of each mechanism.

It is assumed that development of the capacity to learn follows an orderly sequence and that treatment of disability can be most effective by taking the sequence into consideration. Accordingly, when any of the three integrative mechanisms is employed as a basis for treatment, those processes with the greatest organization at the lowest neural levels are emphasized first, then the next most complex function, until the remedial treatment focuses largely on cortically directed activity. Attention is directed to the fact that methods are constantly evolving as the body of knowledge regarding the neural basis of learning grows.

If primitive postural reflexes are poorly inhibited, it is logical to initiate the manipulation of this sensory integrative mechanism by inhibiting the reflexes. The principles proposed by Bobath and Bobath (*4*) provide appropriate rationale for the procedures. Basically, the method involves eliciting in a child a position opposite to that characteristic of the reflex. Lying prone on a "scooter" with head, upper trunk, arms, and legs held up against gravity and pushing around the floor for fun help achieve this objective. Furthermore, the prolonged maintenance of posture possibly activates some of the high threshold muscle receptors that are intimately involved in postural functions. It is the opinion of Rood (*10*) that this neurophysiological process also helps develop control over the primitive reflexes.

When the reflexes are sufficiently integrated into the nervous sytem, the child's inner urge for postural mastery over the gravitational force will almost automatically involve him in the many postural adjustment and balancing activities which encourage development of equilibrium. Oculovestibular reactions inevitably are involved in this remedial approach through natural neurophysiological processes.

The next step in developing integration through this neural mechanism is to provide simple sensorimotor activities requiring integrated sensorimotor function of the two sides of the body simultaneously. Symmetrical or reciprocal motions are more easily mastered than are the more complex ones. Kephart's (*7*) chalkboard exercises appear to meet a remedial need of this type.

Although normalization of vestibular functions and use of considerable vestibular stimulation are effective in improving eye-tracking movements, it is appropriate to involve the eyes in some specific horizontal tracking exercises. These movements can be facilitated by placing the child in the prone position, which requires contraction of the neck and upper trunk muscles and thereby increases proprioceptive flow which enhances normal contraction of the extraocular muscles. The mechanism probably operates through connection of the cranial nerve nuclei over the medial longitudinal fasciculus.

A final step is training in visual perception of sequence in space through simple games. Hopefully, the prior emphasis on the vestibular and somatosensory integrative processes will have prepared the brain for better mastery of visual perception.

Since the basic problem in motor planning involves a disorder of the tactile system, it is recommended that the first remedial step with an apraxic condition is an attempt to normalize the tactile system through careful application of touch-pressure stimuli to hands, arms, face, back, and legs. The response of each child must provide the guidance for determining the method of application. If the stimulation feels comfortable to the child, it is considered to be integrative.

With more spatially precise tactile information reaching the brain, the child learns more about his body and its environment and how to move in relation to both. Activities requiring motor planning help alleviate this type of perceptual-motor dysfunction. Activities on a carpeted surface achieve the ideal situation of tactile stimulation appropriate to the task at hand.

If certain types of visual perception develop out of association with vestibular and somatosensory input, the enhancement of visual perception might well begin with improving integration of these basic sensory modalities. The method proposed is similar to those suggested above, *viz.*, providing sensory input and requiring a motor response that is dependent upon organizing the input. The enhancement of kinesthesia deserves special attention. Prolonged contraction of postural muscles, contraction of muscles (such as that required to stabilize an anatomical segment), and joint traction and compression are believed to be means of increasing discharge from the joint receptors that are responsible for the sense of kinesthesia.

Use of manipulatory toys following enhanced somatosensory perception is appropriate to help develop visual form and space perception.

Concluding statement

In spite of the wealth of basic research data on the function of the brain, very little is known about how it functions as a whole in relation to the development of perception and learning. Since a neurobehavioral approach to reading disability is based on hypothesizing the nature of the brain's function, these thoughts are presented as tentative and part of a constantly evolving theory which will undergo many changes as knowledge unfolds. Meantime, its productiveness warrants its use and continued exploration.

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SOCIOLOGICAL ASPECTS OF READING

Sociocultural Influences and Learning Channels

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THE TOPIC OF THIS PAPER is really more in the nature of a hypothesis than an area of fact and interpretation. The hypothesis stated simply is that environmental circumstances are influential in the process of acquiring knowledge. This statement means that not only *what* one learns but also *how* he learns it are influenced by the social and cultural conditions under which he lives. Evidence has accumulated to show that whatever portion of perceptual function may be innate, substantial portions are learned or at least are modified by experience. The kinds of experience which influence specific aspects of perception and the way in which they are influential should be considered.

First is the question of quantity of experience. Animals reared in sensory isolation do not develop normal sensory processes. Similarly, in human beings sensory isolation produces lack or inadequacy of perceptual function. Of course, human beings cannot be deliberately reared in conditions of sensory isolation, as can be done with animals. There are some "accidents of nature," however, and experiments have been done with adult subjects experiencing isolation for varying periods of time which have yielded data in this area. For example, von Senden (*8*) reported the results of visual testing with subjects who were blind from birth or shortly thereafter but who had successful eye operations and subsequently acquired vision. While the studies were not so controlled as one would wish, the evidence shows that the people who had these experiences had serious visual perceptual deficits. In some cases, depending largely upon the age of the subject, fully normal visual perception was never achieved. Many of the subjects had difficulty with the function called "thing constancy," a term which refers to the ability to see an object as the same object no matter what its orientation in space or the angle from which it is viewed. One of the subjects reported by von Senden, for example, could recognize an automobile easily when both he and it were on a level. That same subject when looking out a window was not able to recognize the objects he was seeing from the top and had to go all the way downstairs to satisfy his curiosity about what he was seeing: automobiles parked on the street. Similarly, some of the subjects did not acquire the ability to recognize geometric forms such as squares and triangles visually: they had to count the corners of the figures in order to designate them correctly.

Chimps raised in darkness, as reported by Riesen (*5*), showed serious perceptual deficiencies, and apparently some of the animals never attained pattern vision.

The foregoing experiments used subjects that were totally deprived of sensory experience in a particular channel for a period of time. Is it not logical to hypothesize that partial restriction might result in *partial* deficit? Such a partial deficit could take the form either of delay in acquisition of full skill or of less-than-full development of skill, independent of time.

One type of restriction of sensory experience might simply be exposure to a more formless visual environment than is the typical one. For example, White (*6*) studied institutionalized infants of mothers who were for one reason or another unable to care for them. These infants were kept in cribs in a nursery from six weeks until six months of age, the period during which White and his colleagues had the opportunity to study them and to modify their environment. The nursery was so organized that there were two facing rows of white cribs with an aisle between them. The babies were kept on their backs, each in a crib, facing a white ceiling. The cribs were equipped with white sheets and white crib mats along the sides for bumpers, and the infants were attired in white diapers and white shirts. The investigator found that for these infants the average age for fisted swiping (hitting an object with the fist) was 65 days, while for reaching and grasping it was 145 days. Then he introduced patterned sheets, removed the crib mats, and hung mobiles and stabiles from the crib. After this exposure, the age of fisted swiping for the experimental infants decreased to 55 days, while grasping appeared at 80 days. These experiments show that early sensory experience can affect function. While there is as yet no basis for saying that later perceptual functions are improved by an earlier appearance of these hand-eye skills, it would certainly seem that the earlier the basic skills appear, the earlier can they be built on by the later, more complex ones.

Another experimential element is practice. Perception consists not only of recognizing a particular figure or object or sound but also of distinguishing the difference between one object or sound and another. This function is called discrimination. It is the thesis here that the quantity of experience in making discriminations influences the level of skill in discriminating. A child who has little practice in discriminating between two stimuli will not be able to do so as readily or as accurately as one who has had more experience. Here the quantity of stimulation reenters too: fewer stimuli mean fewer opportunities for differentiation. Too many stimuli may mean distraction and little opportunity for establishing discriminations.

To bring this down to a concrete example: A child who has blocks that are all of the same color and dimensions to play with may have practice in handling and stacking blocks, but he will not have practice in distinguishing one size or shape from another. A child who has blocks of many sizes, shapes, and colors will get practice in discrimination: however, so many variables will be involved that it is highly doubtful if he will become expert in distinguishing between two sizes or two shapes or two colors, because so many dimensions of the stimuli are varying simultaneously.

Social and economic circumstances influence the availability of stimuli in the environment of the child; to the extent that this availability influences the perceptual development of the child, the sociocultural factors have direct bearing on his perceptual functioning. An obvious channel of influence is the number and variety of playthings a child has, whether these be commercially available toys, homemade objects, or household objects. Generally speaking, a family that has barely enough money for food, shelter, and minimal clothing will not provide a variety of playthings for its children. Similarly, such a family will live in crowded quarters, and the child will probably have much less opportunity to compare similar objects and thus practice discrimination than will be the case for the child from more favorable circumstances. This condition will be true for stimuli in all modalities.

The writer's work has centered mainly on the delineation and test of this hypothesis in the auditory modality. It is hypothesized that a child in the noisy slum environment gets less practice than the child in the quiet middle-class environment in making discriminations between speech sounds. The child in the slum environment has much noise to interfere with his perception of a given sound and at the same time has less verbal signal directed toward him. (This last point tends to be borne out by language research.) While one can avoid seeing particular visual stimuli by closing the eyes or turning the head, so simple an avoidance is not possible for auditory stimuli: one cannot close ears. The way in which one avoids auditory stimuli is by "tuning out" their perception centrally. The problem with this characteristic is that the signal—the stimulus which has meaning and information—is tuned out along with the noise. Thus, it could be postulated, a noisy environment promotes more tuning out, and the child, as a result, not only is exposed to less speech but also perhaps hears a smaller percent of what he is exposed to than would be the case for his middle-class counterpart.

This hypothesis is under test at the Institute for Developmental Studies at the present time, but results are not yet available. However, Clark (*1*) reported finding differences on the Wepman test of auditory discrimination between Head Start (lower-class) children and those of the same age attending a private nursery school. If current research provides similar support, then an inroad will have been made into the difficult area of defining the nature of operation of the effects of sociocultural factors on psychological development.

This central hypothesis has been stated elsewhere with more supporting theoretical material. Now, however, consider modality comparisons. It would seem reasonable, given the nature of the auditory tuning-out process, that the child from the slum environment would get proportionately less practice in auditory discrimination than he would in visual. If so, he might be expected to be somewhat poorer, overall, in obtaining information through the auditory than through the visual channel.

The foregoing is a very difficult area to investigate, because of the practical impossibility of establishing equivalent tests for different sense modalities. However, there is a body of data on presumed equivalents, and since the data come from different sources and from different measuring instruments, a modicum of cross-comparison is possible with the resulting enhancement of the potential meaning of the findings.

Katz and Deutsch (*4*) report that, contrary to most learning studies with middle-class children, retarded readers from the lower-class group consistently have more difficulty with the auditory channel than with the visual, on a variety of tasks. This condition is true for learning tasks and for reaction time and/or vigilance tasks. At the same time the writer has found that the Illinois Test of Psycholinguistic Abilities discloses that lower-class children have greater difficulty with subtests tapping auditory input channels as compared with those presenting information visually. (The exception here in this data is the digit span subtest, which tends to be one of the best for these subjects, but, of course, for which the stimuli are very familiar to the children.) Gray and Klaus (*3*) report similar findings for their group of socially disadvantaged children. Inspection of the data for the standardization group of the test does not yield the same finding. Further tests of this initial finding are planned.

It should be stressed that this emphasis on the relatively lower efficiency of the auditory channel for these children carries no intrinsic, anatomic, or structural implication. The hypothesis about the findings rests on the interaction of the process by which experience influences perception and the nature of audition as compared, for example, to vision.

The potential ramifications of such a finding for education are, of course, substantial. Much classroom work proceeds via oral instructions from teacher to students; further, these instructions are likely to be in a somewhat more complex language system and/or in a different accent than that with which the disadvantaged child is familiar. Under such circumstances, closer attention is necessary; instead, the child may actually be giving less attention.

Even more relevant is the fact that auditory perception and discrimination are very closely related to reading. The writer and colleagues have consistently found and reported (*4*) that retarded readers are poorer on auditory discrimination tasks than are good readers of the same social class level. Younger children show more pronounced differences here than do older children, and the inference is that auditory discrimination is a skill that can mature, even in the presence of reading disability. The greater prevalence of reading disability in disadvantaged children leaves one with the question of how much of this increased prevalence might be attributable to greater difficulty in auditory discrimination tasks.

There are as yet no data to prove or disprove such a speculation. But the question is open to investigation.

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Performance on a Perceptual Test with Children from a Culturally Disadvantaged Background

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THE MINNESOTA PERCEPTO-DIAGNOSTIC TEST (*8*) is purported to aid in the determination of whether children are organically brain damaged, emotionally disturbed, or schizophrenic. It has also been used in the identification of children with primary or secondary reading retardation.

Perception is subject to various influences, according to Fuller and Laird, the authors of the test. For example, personality integration can be a factor in perceptual distortion (*8*). They indicate that an individual who is subject to emotional stress will perceive less accurately than one who is not emotionally disturbed. In addition, the authors indicate that the individual who is organically impaired will have difficulty in organizing the perceptual field and thus distortion will result.

To measure perceptual distortion Fuller and Laird make use of Wertheimer's gestalt designs, which are used in the Bender Visual-Motor Gestalt Test (*1*). Fuller and Laird utilize two of the gestalt designs and present these in three different contexts which emphasize the position of the figure and the framework in which the figure is placed. Rotations are the factors which are scored. The authors contend that rotated figures are indicative of pathology.

Evidence of this fact comes from Fuller's study (*7*). The MPD Test successfully discriminated among groups of children categorized as normal, emotionally disturbed, and schizophrenic. The groups were chosen on the basis of recognized criteria. The results indicated the normal group had rotation scores of 30 or under; the emotionally disturbed group had rotation scores between 31-55; and the schizophrenic group had rotation scores of 55 or over. It should be pointed out that organic children also scored over 55.

Purpose of study

The problem under consideration is the usefulness of this instrument with children who come from a culturally disadvantaged background. The study is an exploratory one which concerns itself with the analysis of the MPD

Test on a population of Negro and Caucasian children from a culturally deprived background.

Specific questions which are raised include: What are the findings of the MPD Test with this group? Can one arrive at conclusions as to the incidence of emotional disturbance and possible brain damage in this population? What is the relationship of performance on the percepto-diagnostic test to reading achievement?

Because the teacher is of primary importance as a director of learning, her perception and understanding of the children are important. Therefore, it might be helpful to look at the teacher's rating of the pupils' adjustment and analyze and relate these findings to the test material. One question which this study explores is this: Are there any relationships between teacher rating of adjustment, achievement, and scores on the MPD in Negro and Caucasian children?

Procedure

One Negro and one Caucasian school were chosen from several schools in a metropolitan school system serving culturally disadvantaged children. Criteria utilized in the selection were as follows: 1) geographical location of the school; 2) consensus of experienced school personnel as to suitability of the school as one serving culturally disadvantaged pupils; and 3) similar low standardized test scores of the students.

A random sample was drawn from the two third grade and two fourth grade classes in the Negro school and from the third and fourth grade classes in the Caucasian school.

Since the MPD Test was developed for use with children within the age range of 8 to 15 and with intelligence quotients from 80 to 110, children who did not meet the criteria of suitable range of intelligence were dropped from the study. In addition, subjects were also eliminated who did not have scores on all the measures under study.

To obtain an index of intelligence, the Goodenough Draw-A-Man test (9) was administered to each child. Because of the possible influence of poor educational background on reading level, a verbal group test of intelligence was not administered. The MPD Test was then administered. Both tests were given individually by the investigator. The Metropolitan Achievement Test (reading battery) was administered to each grade by the respective classroom teacher.

Classroom teachers rated the personality adjustment of each student. The Child Behavior Rating Scale (3) provides five scores: self adjustment, home adjustment, social, school, and physical adjustment. Each child is rated on a six-point scale as to the degree he exhibits the specific behavior being rated.

Results

The Negro and Caucasian groups did not significantly differ as to intelligence scores as measured by the Draw-A-Man test. (Negro = 90.70, N = 19; Caucasian = 91.54, N = 11, t = NS.) It was especially important to note any differences between groups on the intelligence variable as Fuller and Laird emphasized that the degree of rotation on the MPD might be influenced by intellectual factors.

Though not differing in intelligence, the Negro children had a significantly higher rotation score in comparison to that of the Caucasian children. The mean score for the Negro group was 91.58 and for the Caucasian, 58.90 ($t = 2.65$; significant at .05 level). Both mean scores are above the cutoff point of 55 recommended by Fuller to distinguish between pathology and normality.

On the word knowledge and reading comprehension subtests of the Metropolitan Reading Test both groups scored below the norms. While the Caucasian group appeared to perform somewhat better on the comprehension test, when scores are expressed in stanine units the differences between the two groups on both tests are not significant (Word knowledge test scores: Negro = 4.05; Caucasian = 4.27 NS.

Reading comprehension: Negro = 3.63; Caucasian = 4.18 NS).

Do teachers view as maladjusted these children with a high degree of rotation? Comparison of the two groups indicated the six teachers involved in the study perceived their students as average in adjustment. The writer thought the school adjustment scale alone might reflect more differences because this was the one area that dealt specifically with behavior in school.

However, when the groups were compared on this scale both again reflected "average" adjustment. Differences between the Negro and Caucasian groups were reversed when rotation scores on the MPD Test were considered. That is, while the mean rotation score for Negroes reflected poorer adjustment, the mean overall adjustment score for this group was higher (reflecting better adjustment) than for the Caucasians. Because score differences were in the opposite direction, significant tests were not run.

Discussion of results

What is the meaning of these results? Could these children all be disturbed or organically impaired? Could perceptual adequacy be a factor of economic circumstances? The factors which should be considered are:

(A) Adequacy of the study setup is important. While a random sample of children was used, the sample was small (N = 30) and came from a very disadvantaged area of the school district. There is also a need to study more children on the disadvantaged-advantaged continuum.

While this sample was a biased one and planned as such, before implications can be drawn as to culturally disadvantaged children in general, children from a wider range of culturally deprived backgrounds should be investigated.

It is possible the Negro sample included a larger number of children with a disadvantaged background. If his circumstance exists, it might be a actor in the differences in rotation scores between Caucasians and Negroes on the MPD. However, it should be noted that the achievement test scores did not differ significantly between the groups.

(B) In addition, the Draw-A-Man test might not have been a wise choice. While one study (*2*) found the coefficient of correlation of the Draw-A-Man with socioeconomic status to be quite low, the same study showed that the IQ scores for the Draw-A-Man were definitely lower than ones obtained from group verbal tests. On the other hand, Lindner (*11*) questions the validity of his Draw-A-Man scores because the coefficients of correlation with the Stanford-Binet ranged from only .29 to .59; Lindner's subjects were Negroes. However, the writer feels there is a need to consider other possibilities to account for the differences noted in this study.

(C) Deutsch postulated that restriction of stimulation negatively affects the organization and integration of the components of the child's cognitive potential. He emphasized that the culturally disadvantaged child has fewer opportunities to "manipulate and organize the visual properties of his environment and thus perceptually to organize and discriminate the nuances of that environment" (*6*:170). Deutsch specifically includes here figure-ground relationships and spatial factors.

(D) Another factor to be considered is the incidence of prematurity in the lower-class segment of the population. To the extent that "reproductive casualties" are found more frequently in the culturally disadvantaged population, a greater incidence of high rotation scores might be theorized. Wortis and Freedman (*14*) commented that children whose nervous systems are defective or vulnerable may be more sensitive to a poor environment, and thus negative factors found in such an environment may more readily bring forth a different pattern of development in the child (*14*:65).

(E) Another point to consider in these results stems from the work of Pacella (*12*) with brain damaged retardates. He measured the performance of these subjects on successive trials of the Bender-Gestalt and hypothesized that a single Bender-Gestalt protocol was not sufficient for a satisfactory evaluation of visual-motor development. He hypothesized there would be no differences on the first trial between organic and non-organic retardates in accuracy of Bender reproductions but such differences would be noted on the third trial. He theorized that organic subjects were "deficient in coordinating perceptual experiences with motor behavior" and are "therefore less likely to profit from learning, while with the nonorganic retardates it is simply a matter of being slow to learn and their performance will improve on repetition."

To transfer this concept to the present study, it is possible that upon further repetitions of the MPD figures the "true" organic cases might appear and the high scores of the other children would slowly improve: thus one would obtain a more realistic picture of their performance on the MPD test. To ascertain the validity of this hypothesis one would need independent judgments as to the presence of organicity.

(F) Deutsch (*5*) is concerned about the method of presentation of perceptual tests. She feels the results from a figure-copying test such as the Bender-Gestalt cannot be clearly analyzed as to specific causative factors. Her preliminary results "indicate that in a perceptual-motor test what is being measured primarily is the motor or the coordinated perceptual-motor skill, rather than any 'pure' perceptual ability" (*5*:*367*).

(G) Wepman (*13*) postulated three main functions in the visual perceptual act: 1) discrimination; 2) memory, retention, and recall; and 3) sequential patterning. He also stated that a fourth function should be added: intermodal transfer, which is the ability to shift from the visual modality to the auditory modality or vice versa. Is it possible that culturally disadvantaged children are deficient not only in discriminative skills but also in their sequential patterning and ability to shift modalities?

(H) Is it also possible that De Hirsch's concept of "neurophysiological immaturity" (*4*) may explain the results of the present study? Would the presence of such immaturity in a child living in a disadvantaged environment produce an even lower level of performance than otherwise? Once again it is emphasized that unfavorable conditions within the individual interact with unfavorable external environmental forces to produce a less than adequate perceptual performance.

Thus, one could hypothesize that two children with equally high rotation scores on the MPD test could obtain such high scores with the involvement of various factors in differing degree. The performance of a child with organic brain damage from an adequate environment could reflect mainly the negative effects of the conditions within the individual while with a culturally disadvantaged child the effects of neurophysiological immaturity, or existence of a mild deficit (conditions within the individual), could interact with less organized stimulation sequences, lack of variety of stimulation, and lack of practice in coordinating perceptual experiences with motor behavior (conditions outside the individual or in the environment) to produce an equally high rotation score.

(I) To ascertain further the important variables involved in the performance of disadvantaged children on the MPD a group of such children who were also severely retarded in reading were studied. These culturally disadvantaged children were referred to a "learning improvement" center because of severe reading disability. They were from another school system than the one in the first part of the study. Therefore, the conclusions are restricted in scope because of the two different populations. However, it appeared helpful to compare the performance of this clinic sample of disadvantaged children with the sample drawn from the larger school population.

The clinic sample is similar in age and intelligence to the first group of subjects (Mean CA, 10 years; mean IQ, 96.06). Consecutive admissions of 15 children to the learning improvement center were studied. The examination procedure included the administration of an individual intelligence test, personality appraisal, achievement tests, neurological examination, and collection of medical and social history data.

To ascertain further the extent of underachievement, a discrepancy index between intelligence level as measured by the Wechsler Intelligence Scale for Children and reading level as measured by the Wide Range Achievement (*10*) was computed. When the data were converted into grade placement scores, the reading performance scores fell an average of 1.96 grades below reading capacity.

The MPD test was also given to each of the 15 children. The reading disability group from the clinic was composed of 14 Caucasians and 1 Negro child. Administration of the MPD resulted in a mean rotation score of 78.45. The degree of rotation is more extreme in these clinic cases than in the Caucasian sample reported earlier (Caucasian sample = 58.90 mean rotation score; clinic sample = 78.45 mean rotation score; $t = 1.73$, significant at .05 level). The range of scores was from 44 to 122. No one in the clinic group earned a "normal" score on the MPD.

On the basis of the data, it appears that the MPD performance of disadvantaged students in regular schools can be differentiated from that of a clinic sample reflecting severe reading disability.

However, it must be noted that these two groups from a culturally disadvantaged population show higher rotational scores than those reported for various groups in the standardization of the MPD. The very high rotational scores from the Negro sample indicate that further study is needed with Negroes from a culturally disadvantaged background.

Investigation of the clinic sample is continuing in an effort to relate performance on other variables, such as neurological data, with rotational scores on the MPD.

(J) The results of these studies indicate that the factors involved in the performance of children from a culturally disadvantaged background are varied and complex. Further studies should be aimed to isolate the important variables affecting learning and personality adjustment.

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PERCEPTION AND BEGINNING READING

Kindergarten Perception Training: Its Effect on First Grade Reading

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THE QUESTION of kindergarten perception training is both timely and complex. Many educators are reviewing the matter and are stimulated by the implications of the research for beginning reading programs. In addition, the complexity of the perceptual process itself and of the factors which influence it add additional dimensions to an investigation of the question. It is necessary, therefore, to delimit the subject and make some assumptions.

It is assumed in this paper that selected activities in perception training could have a beneficial effect on first grade reading and that some children are ready for direction. The activities could be classified with Sheldon's term (*11*) "pre-book learning and oral language development"; but, nevertheless they are activities which attempt to accelerate the development of skills associated directly with known perception problems of first grade reading programs. Without minimizing the importance of physical, social, emotional, and mental maturity factors, it is also assumed that these factors will permit the students to progress on a perception training program with some measure of success. The difficult questions of how best to identify the students who are ready for perception training and to decide whether they *should* participate are not considered here.

Specific approaches and programs which include computerized typewriters, visual perception kits, and sets of flash cards are well known and will not be discussed. Instead, an attempt will be made to cite research in child development that will serve as the bases for suggestions of possible approaches for perception training. Of special interest are some of the recommendations made by Chall and Feldmann (*2*) in their survey of first grade reading programs.

The perceptual process in reading

Perception is a form of behavior that results in an organization of incoming sensory data (*12*). Visual perception according to Vernon (*13*) is a four-part process in which the child reading the word attends to it until he can name it or describe it in other words. First, he is aware of the visual symbols standing out from the background of the page of the book, and then he sees essential similarities for the general classification of the word. Third, he classifies the visual symbols of the word within the general class. Last, he identifies the word, usually by naming it. Visual perception is a learned process which encompasses consideration of acuity, discrimination, and memory. Auditory perception may be viewed as a parallel process to visual perception taking similar account of acuity, discrimination, and memory. Both auditory and visual perception receive attention from first grade teachers as the important auditory-visual associations are made between sound and letter symbols. The remarks in this paper are confined to some of the aspects of auditory perception and to the impact of oral language development on perceptual development.

The establishment of the code

As children grow and develop through the preschool years, they learn to discriminate most of the characteristic speech sounds of English. Each sound has a number of measurable attributes, such as frequency and intensity. Sounds are most frequently conducted to the child's ear by waves airborne and are usually heard on a time sequence, that is, one sound after another. A sequence of sounds which make up a word is bound by the juncture or pause before and after the word.

Moreover, during the same preschool years the child is becoming acquainted also with objects in his visual field, the majority of which possess three dimensions: length, width, and depth. These objects are viewed primarily in space although time enters in as successive parts of an object may have to be viewed before the entire object is seen. Spaces often show the boundaries of objects just as pauses or silences separate sounds.

Because sounds have little permanency, man learned to capture them by devising letter symbols to represent sound symbols. These visual symbols are usually two dimensional on paper and have the advantage of being a more permanent record of a communication. In this way a code was formed, comprised of a set of letter symbols representing the characteristic sound symbols of English. In English this code is very complex as there are few instances in which one printed symbol stands for just one sound symbol.

By tradition, the children are usally confronted with this code in the first grade reading program although in many of the programs the first and main emphasis is on meaning, not on the learning of the code. That is, in the initial lessons words which are in the children's oral vocabulary are learned in printed symbol form as sight words without too much concern for the learning of the code itself. Chall and Feldmann (*2*) recommend that attention focus first on the code. In the beginning of the first grade reading program, teachers use the words in the children's oral vocabulary and teach which letter symbols stand for the sound symbols in the words. Teachers recommend, in effect, that the children be first taught the code. It should be remembered that meaning is not ignored. They recommend the use of words the children use and know in their speech. Once the code is mastered, no furt' r emphasis is given to it.

This study is a very significant one, which should have an impact upon the thinking of educators interested in kindergarten programs. With this code-st approach in mind the reader is asked to consider some of the problems in perception and the possible implications for kindergarten perception training programs.

The distinguishing of individual sounds

To read, the child must be able to hear and distinguish the separate sounds in words. Hearing, however, is a developmental process made up of a series of factors which exhibit individual rates of development in children (*15*). As a result, when the child comes to school, there are some sounds of English which he probably has not yet mastered. He cannot hear them, and he cannot produce them correctly in their accepted positions in words. Unless the maturing process can be hastened without putting him under undue stress, there will be parts of the code in his beginning reading programs which the child will not be able to master. In other words, there will be some sound symbols which, not being able to discriminate yet, he cannot associate with an accepted printed symbol. Which sounds are these? How might a kindergarten perception program help to correct this situation?

Wepman (*14*) sets forth the sounds of English which are not mastered in speech until six years and older. Newby (*7*) reported that the ear is not equally sensitive to all frequencies with the result that greater intensities are required for the higher and lower ends of the frequency scale. The speech sounds whose distinguishing characteristics are in the higher frequencies are the voiceless consonants (*p, t, k, s, f, sh, ch*, and the voiceless *th*). A comparison of the Wepman and Newby lists shows that a number of sounds appear in both. As Olmsted (*8*) predicted in his theory of the child's learning of phonology, a voiced sound (that is, the vocal cords vibrate during the production of the sound) is easier to discriminate than a voiceless one.

These voiceless consonant sounds, therefore, are among those for which brief regular training sessions could be given during the kindergarten year.

As there is less urgency in training sessions, the child is not under pressure to discriminate the sound symbol so that he can attach it to a letter symbol counterpart. He should have no reason to withdraw from the sessions as may happen in first grade speech and reading sessions.

One teaching approach could be that in which minimal pairs are presented to the child for his discriminatory response of "same" or "different." A minimal pair is two words which differ only by one sound as in *th*in-*b*in. One word would contain the sound not yet mastered with the other word of the pair composed of known sounds.

It should be noted, too, that kindergarten teachers' voices tend to rise in pitch when they are tired and make it harder for children to hear some of these voiceless consonants. Perhaps more consideration could be given to the normal pitch level of the kindergarten teacher's voice in teacher-education programs so the teachers would be aware of attendant sound discrimination problems of the children listening to them speak.

Dykstra (*3*) reported that in his study of first grade children the boys apparently learned auditory discrimination skills less readily than girls. It has been reasoned that boys spend more time outside the home and do not have the same opportunities to hear their mother's speech patterns which are usually clearer than the less well-defined speech patterns of their young friends. In prereading activities in kindergarten, then, training periods in auditory discrimination could be held separately for the boys who need more help than the girls.

The distinguishing of a succession of sounds in known words

An additional problem in perception is the inability of the child to distinguish the separate sounds within a word when he hears them in sequence. The problem is one of the discrimination of sounds in succession. This ability is not difficult for the literate adult as it has become a well-automatized mental action. For the child, however, it is hard to form the mental action of hearing and distinguishing sounds as they are heard in succession in words. Such is the opinion of Elkonin (*4*) who explored this problem in Russia with preschool children, ages 6-7. He believed that children who are struggling with this problem should not be expected to begin their work on the adult level. That is, they should not begin to analyze a word into its sound components upon the presentation of a speech cue from the teacher. The task should be accomplished in easier stages which follow.

In tasks involving the forming of a mental action about objects, a child is free to touch, see, smell, taste, and listen to them. He learns about the object on this concrete level before proceeding to the internalizing of the actions at which stage he can think about the object without having to have the sensory cues. He has speech to help him think about and talk about the objects in their absence. The process of internalizing actions proceeds gradually from the concrete to the abstract.

However, when the objects in question are sounds themselves, their transitory nature makes the task of learning to perform mental actions involving sounds a much more difficult task. The child cannot see, touch, smell, or taste sounds. He can only listen to them.

Elkonin (*4*) suggested that the word in which the child is attempting to hear and distinguish the sounds be depicted in a drawing, as a means of materializing the sounds which pass away so quickly. Underneath the drawing of the object the investigator drew a box made up of horizontal squares, one square for each sound in the word pictured. The word depicted in the drawing was spoken to the child and the desired response from the child was demonstrated to him. As the investigator named each sound, he placed a counter in each square under the picture. He then said the word again. This procedure means that the child was always working with a word known to him in his speech and illustrated for him. In addition, he heard the word as a whole, and then after the analysis he heard the word again as a whole.

By continued demonstration and explanation, the task of naming the sounds in order in a word was made clear to the child. Galperin (5), upon whose study Elkonin based his investigation, belived that this first step was of special importance. He suggested that the child would not himself perform any action for a time but he could be encouraged to take an active part in the teacher's demonstration by prompting her next operation or by naming its result. By means of language the child exhibits his control over the action. Learning to discriminate the sounds within a word would mean that the child would be encouraged to volunteer the next sound that the teacher was about to say either saying it with the teacher or saying it for the teacher.

Gradually the child would become involved more completely in the process. When he heard the word, he would attempt to name the sounds within the word and would place a plastic counter in each horizontal square for each sound named. The visual presence of the picture and the manipulation of the counters would help to materialize the sounds and help the child bring this action to a concrete level where he could discover it for himself and become familiar with it. Many drawings of objects well known to the child would be presented in the same way until the child could be said to have mastered the action of distinguishing the sounds in several words.

In the next stage the counters and the drawings would be gradually withdrawn. Now when the child heard the word, he would repeat it and then attempt to name the sounds without the help of either counters or drawings. Once again, sufficient time must be taken to be sure that this step is mastered before the next one is introduced. The gradual withdrawal of the drawing and the counters is the first in releasing the action from the concrete and placing it entirely on the plane of audible speech.

In the final step, the child upon hearing the word would learn to perform the sound analysis mentally without pronouncing the word aloud to himself. Galperin (5) achieved this by showing the child how to whisper the word to himself and then finally to say it to himself without producing any audible sound. When the child heard the word, he would whisper it to himself and then would whisper the individual sounds in order. At the conclusion of this recitation he would whisper the word again to himself. This whisper would gradually disappear until the naming of the word and of its component sounds would be performed mentally only. He could, of course, name the sounds in the words when he was asked to do so; but the action would be well established mentally and would only be brought to the level of audible speech again when the occasion warranted it.

After much practice this ability would be generalized, and the transfer to new words of any difficulty could be effected. With this ability the child in the first grade could learn to attach each sound symbol in a word to its accepted letter counterpart; that is, he could learn the code and apply it. Once the code was learned, the process of attaching groups of sound symbols to groups of letter symbols would follow rapidly.

This approach has worked for others, and it may merit consideration.

The role of language in the development of perceptual activity

The development of perception is inseparably associated with the development of thinking; language development facilitates immeasurably the development of both of them. Perceptual development is basic to abstract thinking. The goal may seem far away to the kindergarten teacher, but the program and activities of the kindergarten, nevertheless, play a basic role in making possible future developments in thinking abilities. Once the child acquires sufficient language to communicate with his own inside world and with the outside world, the speech, accuracy, and fineness of his perceptions develop rapidly. What then might the kindergarten program undertake in oral language work to ensure the greatest possible perceptual development?

A brief review of how the child acquires syntax will isolate a number of pertinent facts. Brown and Bellugi (*1*) reported that the young child selects the noun and verbs more often than the adjectives from sentences spoken to him. These are the high-information words which receive the heavier stress in adult intonational speech patterns. For example, from the sentence "Daddy is coming down the street" the young child selects "Daddy coming street" to reecho.

What he chooses to omit is of concern. The forms he leaves out are the grammatical functions, the low-information words. These are the inflections, auxiliary verbs, articles, prepositions, and conjunctions. These function words have meaning, but it is meaning that accrues in context rather than in isolation. During the remaining preschool years through imitation of the language patterns of his elders, the young child gradually expands his own oral output and learns to include these function words in his communications. His achievements are so remarkable that he is credited often with the counterpart of an adult command of the structures of his language.

To assume that just because the child uses words and grammatical constructions acceptably he has a commensurate understanding of them is dangerous. More than 30 years ago Piaget (*9*) wrote about children's verbalism. He found that the child used grammatical forms before he could grasp the structure of meaning corresponding to them. In other words, use of language structure by a child is not necessarily a guarantee that he has the understanding some adults would credit to him.

The implication for kindergarten programs is clear. The years of preschool training can profitably be used in a twofold development of oral language. The first prong of the program would be a systematic language development program to ensure that each child was developing toward a mastery of the elements of the grammatical structures of English. This program would include a check on the function words such as prepositions, adverbs, and conjunctions—and the inclusion of directed teaching where necessary. The second prong of the program would be interrelated with the first to ensure a continuing development of understanding in the use of the various grammatical forms.

The writer's research in reading disclosed that even at the fourth grade level children could answer correctly only slightly more than half of the multiple-choice questions built up from sentences containing conjunctions (*10*). From the understandings of child psychology it is not difficult to understand the reason that children stumble at the meaning of *although*, *however*, and *thus*; but the fact remains that the writings they are expected to read contain these relational words in abundance; yet they are rarely given directed help in the understanding of the words and the constructions in which they occur.

Liublinskaya (*6*) cited an investigation in which one group of preschool children were given instructional activities in which they had opportunities through games to investigate the interrelationships of words such as *under* and *over*. The game activities were always accompanied with opportunities for guided discussions led by the instructor. Many times pictures were used; but no matter what the medium was, the children had the opportunity to investigate the relationships ascribed to the function words on the concrete level and through speech. A control group which had no such opportunities lagged behind the experimental group in which there were substantial changes in the children's speech.

Although no one can predict for a kindergarten teacher what the particular language needs of her group will be, a few working principles may be helpful. First, she should appraise the language needs of her group from the standpoint of their understanding of grammatical constructions. Then she should list the areas of weaknesses and isolate those needs which could be included in a total program. Second, each of the language needs should be developed systematically.

For example, suppose the need were a greater understanding of the conjunction *when*. Practical activities that will confront the children with the meaning associated with the use of *when* should be devised. One could say to Brenda, "When you bring me a book, I will give you a pencil." Then one could continue the activity by saying, "When Brenda gives Jim the pencil, Jim will bring it to me." Before long, the children will be participating more fully in the activity, and through both activity and discussion they can develop their idea of the meaning of *when*.

This particular lesson should be repeated with this or other activities until the children through these direct experiences have a more exact understanding of the word. Then at desired intervals throughout the kindergarten year, checks on the understanding of this point should be made. In the meantime, there should be other lessons directed at the development of understanding different conjunctions, prepositions, and other function words.

Finally, it is imperative that the teachers understand and explain the purposes of the activities. The children may mimic sophisticated grammatical constructions but understanding of the constructions will develop far more rapidly and surely if the objects, actions, and events can be brought down to the action or concrete level. Then the children can participate in them to a greater degree and apply their competencies in speech to help them develop meaning for the structures they have learned to mimic so well.

Problems abound in such ventures but groups of kindergarten teachers working together can devise programs so that children can perceive better and can have greater competency in oral language to help them.

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Some Effects of Perception Training in Kindergarten on First Grade Success in Reading

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THE PURPOSE of this study was to investigate effects of selected kindergarten lessons in perception upon first grade reading achievement. Twenty-eight kindergartens in a large school district in northern California were used.

Thirty-two kindergarten classes were tested with the Winterhaven Perception Ability Forms Test (P.A.F.T.) and the Goodenough Draw-A-Man Test in September of the year. Out of these, 14 classes were chosen at random for a control group and 14 classes, for an experimental group. The children had been randomly assigned to all classes. The P.A.F.T. was given again in May to determine growth in perception.

The following year the children from the experimental group entered the first grade on the basis of 13 to 18 children per class. The teacher did not know which children were experimental and which were control subjects. The classes were given one form of the Gates Primary Word Recognition Test in November and another form of the same test the last week of May.

Teachers were chosen at random for either the control or experimental classes from a group of 22 teachers, matched on years of experience and teaching competence. Each of the kindergarten control and experimental group teachers received in-service training on the new kindergarten guides from both county and district; also in-service in the area of development of language skills in kindergarten children was given all teachers taking part in the experiment. Teachers of the experimental group received training in teaching perception skills in addition to gaining help from the guide and language training.

The perception training consisted of the use of materials and methods advocated by Frostig, Strauss, and Kephart, as well as materials and methods suggested by this writer. Teacher-made materials, following the five areas of visual perception identified by Frostig as Visual-Motor, Figure-Ground, Position-In-Space, Form Constancy, and Spatial Relations were also utilized. The Winterhaven program for perception was added with template training and form recall. Template training was planned for no more than three times a week. Manipulating objects to ascertain relative size, shape, and texture, classifying into ordinate categories, and simple coding were also taught.

Language experience and the learnings outlined in the kindergarten guide formed the basis for both the experimental and regular kindergarten programs. Perception training was added to the program for the experimental kindergartens.

When the experimental class teachers became conscious of perception development, they often incorporated training in perception in traditional kindergarten activities such as rhythms, block design, bead stringing, and building blocks. Body schematic exercises became a part of rhythmic activities; and block design, bead stringing, and building blocks were manipulated into patterns to match increasingly complicated designs made specifically for the children to follow.

Kindergarten September test results

Based upon the Goodenough test of intelligence, the mean IQ for the control group was 101; for the experimental group, 99. The difference between the two groups was not significant. P.A.F.T. results showed the control group averaged 53.49 in September at which time the test group scored 34.79. Such a deviation could occur in any group, as both scores fall within the normal range, and it is a happenstance in favor of the control group. The largest growth in perception appeared at the 40 to 45 range, and there were more children in this perception range in the control group than in the experimental group. Using chi square formula, the difference was significant at the .01 level.

Kindergarten May test results

The control group scored 62.16 in perception on the P.A.F.T. and the experimental group, 69.79. Using chi square formula, the difference in growth between the two groups is not significant. The score, however, indicates an increase in the average for the experimental group of 35 perception points as compared to only 9.67 average perception points for the control group.

First grade test results

First grade findings show that the control group increased from a Gates word recognition raw score average of 8.69 or 1.8 grade level in November to 14.14 raw score average or 2.06 grade level in May. The experimental group showed a growth in mean score on the Gates Word Recognition Test from 16.27 raw score average or 2.13 grade level in November to 23.40 raw score average or 2.3 grade level in May.

Using chi square formula the difference in November was significant at the .01 level. Using the same formula the May score also showed a significant difference at the .01 level in favor of the experimental classes.

It should be noted, in this context, that the test group final score distribution figure has a bell pattern or normal probability curve. The reason the other score distribution did not follow the foregoing pattern was due to the impossibility of procuring degrees of zero.

Other findings

The experimental group obtained greater gains throughout the study because of the effect of perception training in the kindergarten. In order to carry out the perception training, the following were necessary: 1) diagnosis of children's learning needs in kindergarten; 2) individualization of instruction; 3) teacher gains in knowledge of child growth and development and perception of young children as part of their total growth pattern. (The teachers mentioned this as the most important factor in their individual growth as teachers.); 4) teachers' encouragement if children desired to experiment with words and simple syntax; and 5) encouragement to read in other places a given word, after recognizing it once. (The experimental group of children asked for a word in a book more than three times as often as did those children in the control group.)

Children were taught reading when ready from a growth standpoint, and their time was not wasted with prereading activities in the first-grade unless it was necessary for a particular child.

Conclusions of the study

A rigorous study was made to determine if a formal perception program in kindergarten would contribute to the growth of perception in children at the end of the kindergarten year and contribute to success at the first grade level.

The children, chosen randomly and placed into two groups of fourteen, were each given the P.A.F.T. in September and May of the kindergarten year to determine growth in perception and tested with the Gates Word Recognition Test in November and May of the first grade to determine growth in reading ability.

Test results showed significantly greater growth in both perception and word recognition achievement in the experimental group than in the control group. These differences favored the experimental group at the .01 level.

Observations pertinent to the study

The teachers felt pressure in teaching the entire program in a half-day session kindergarten. It was generally felt that it would have been easier in a full-day-session kindergarten, but there were none in the district in the locale of the study. Lacking the opportunity of a full-day-session kindergarten, a preschool program feeding into a perception-oriented, language-experience kindergarten may help both the child to learn effectively and the teacher to instruct effectively. Growth in perception, creativity, and communication skills might be the goal of the kindergarten and preschool programs.

The following kindergarten techniques were considered particularly valuable, although time-consuming on the part of the teacher: analyzing growth patterns of children and grouping according to needs; individualizing instruction; constantly evaluating children's progress; preparing manipulative work outside classroom hours; preparing work outside of classroom hours, to increase verbal and creative skills; learning new ways of doing familiar lessons; and planning activities on a very flexible three-to-six group basis during the day (which meant extra planning and organization).

Every day perception lessons, including templates, author-made perception training activities, Frostig exercises, as well as manipulative techniques, were part of the curricular offerings. Body schematic exercises were given to the children by the teacher, and the relative position of objects in relation to the child's own body was part of the daily teaching assignment. Directionality techniques not only helped the child orient himself to his environment but also helped him to develop dominance. Building blocks and bead stringing, according to patterns, were also used to strengthen perception. Cut and paste work, as well as art techniques, added to needed skills. With these techniques, and many others, the children developed some of the skills necessary for successful reading.

A post study will be made to determine if the children taking part in the study and remaining in the school district continue to progress at their present more advanced academic level as compared with others who did not have this type of kindergarten training.

An Investigation of Visual Discrimination Training for Beginning Readers

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FROM THE MANY FACTORS that contribute to readiness for beginning reading, this study concerned itself solely with the factor of visual discrimination. It is apparent from the literature that skill in visual discrimination is a major factor in beginning reading and that skill in visual discrimination is learned. Smith and Dechant feel, to a certain extent, that this skill can be improved by direct training (*6*).

In her work on perceptual development, Gibson raised the question of how much learning might take place (*4*). One possibility that she discussed is that the child be provided with a kind of feedback so that he can compare his own output with another repetition of the standard.

The development of visual discrimination is one of the major objectives of instruction in beginning reading. Heilman indicated that while maturation cannot be hastened, visual discrimination can be "sharpened" through experience and practice (*5*). Smith and Dechant believe that the direct training of visual discrimination constitutes one of our major responsibilities in the child's early reading program (*6*). It appears that the school must provide as much of this experience as is needed, and different children may need varying amounts.

Readiness lessons found in most of the major reading programs provide lessons requiring visual discrimination. However, these lessons are not likely to be built on the letter forms used in later reading lessons but are concerned with learning to discriminate pictorial forms and geometric shapes from one another. It is not certain whether such teaching has much effect on learning to recognize letters and words. Gates found only low coefficients of correlation between discrimination of geometrical figures and reading ability (*3*). Vernon believes that learning to discriminate meaningless shapes from one another does not have much effect on learning to discriminate letters and words (*7*).

Fries suggested that the first set of recognition responses to be developed are those for the letters of our alphabet (*2*). He is supported in this idea by Anderson and Dearborn, among others, who feel that individual letters constitute the most important cues in word perception (*1*).

Fries indicated not only that the first set of recognition responses to be developed should be those for the letters of the alphabet but also that the letters must be identified as contrasting shapes and this identification of contrasting letter pairs practiced " . . . until the child's recognition reactions to the significant features that separate each letter from all the others are automatic" (*2*).

Purpose of the investigation

The major questions this study sought to answer include the following: 1) Will those kindergarten students who are trained to make instant responses of recognition to the capital letters of the alphabet show a significant difference in their visual discrimination ability from those kindergarten students who did not receive this training? 2) To what extent can instant responses of recognition to the capital letters of the alphabet be trained during the readiness period prior to formal instruction in reading?

Methods and procedures

Before the opening of school in September 1964, three schools in the Phoenix Elementary School District Number One, Phoenix, Arizona, were selected to participate in this study. The three schools represented extremes in a socioeconomic continuum within the district. An attempt was made to establish the fact, based on the available census data, that the children in this study were representative of two different environments within this school district. It was realized that the term *high socioeconomic group*, as used in this study, would not hold if it were removed from the context of the Phoenix Elementary School District Number One. The same might apply to the term *low socioeconomic group*, as used in this study.

All children attending the morning kindergartens in these schools were administered visual discrimination subtests one, two, and four of the Lee-Clark Reading Readiness Test and a Letter-Form-Training Criterion Test. The three visual discrimination subtests of the Lee-Clark Reading Readiness Test were administered to the children in small groups of not more than ten in each group.

The Letter-Form-Training Criterion Test (L F T Test) was designed by the writer to assess the child's ability to make instant responses of recognition to the capital letters of the English alphabet. The test material is presented on a filmstrip, which consists of two practice frames and 26 frames of actual test items. Each test item represents one letter of the alphabet flashed by a tachistoscopic device for approximately one fortieth of a second. The child is required to recognize instantly the stimulus letter and then select that letter from four letters displayed on a card. For example, the letter *H* is flashed, and the respondent must pick that same letter out of the letters *F*, *H*, *E*, *A*. The practice frames show the child where to look and how he is to respond and allow time for him to become acquainted with a tachistoscopic presentation.

All children were given the Letter-Form-Training Criterion Test on an individual basis. It was administered as a control on prior ability to perform the task of instant responses of recognition.

A random selection was made from an alphabetical list of these 98 kindergarten children to determine the experimental and control groups. Transfers and illness resulted in a final sample population of 90 children. Forty-five were placed in the experimental group; and 45, in the control group

The children in the experimental group were given training to establish instant responses of recognition to the capital letters of the alphabet. This training was attempted by means of a series of five filmstrips which introduced 16 upper case, unadorned capital letters. The eight stick letters introduced were *I, T, F, E, H, A, M, N*. The four stick and circle letters introduced were *D, B, P, R*. The four circle letters introduced were *U, O, C, S*. The experimental group received 15 minutes of training a day, five days a week, for a period of one month.

The child was expected to visualize the significant features of the contrasting letters presented in each exposure. Each student was required to indicate if the contrasting letters were the "same" or "different." For this task each student was provided wtih three cardboard squares and three cardboard circles. The child was then taught that a square represented contrasting letters which were the same and that the circle represented contrasting letters which were different.

The first filmstrip used introduced the stick letters *I, T, F, E* in 30 combinations of contrasting letter pairs. The contrasting letter pair *E* and *F* was flashed. Since the children were taught that a response to "different" called for a circle, they were expected to display one circle on the table before them. The second frame was then exposed and held on the screen showing the *E, F* preceded by a circle. The children could then compare their response to the standard shown on the screen. Those who correctly displayed a circle were reinforced by the standard on the screen; those who had displayed a square were helped to see that the *E* and *F* were "different" and that a circle was used to respond when two things were "different." The same procedure was followed when a contrasting letter pair that was the "same" was flashed, for example, *E, E*.

The filmstrips were shown by means a standard filmstrip projector with a tachistoscopic attachment for use when flashing was required. For each frame of contrasting letter pairs shown, the instructor called the children's attention to the significant contrastive features of the letters after the children had first responded to them by use of their squares and circles.

At the conclusion of this training all children in both groups were again administered subtests one, two, and four of the Lee-Clark Reading Readiness Test and the Letter-Form-Training Criteria Test. Exactly the same procedures were followed as described in the pretesting.

The statistical technique of analysis of covariance was employed to provide a measure of attaining control of individual differences when testing for significance.

Results

To control on individual differences in aptitude and ability which might have had an unbalanced influence on the mean criterion of the groups of students trained by the different methods, subtests one, two, and four of the Lee-Clark Reading Readiness Test were administered during the first month of the 1964-1965 school year. Since these kindergarten children were tested at the outset of their first school experience, it was assumed that the foregoing test would be a valid measure of the child's ability to make visual discriminations prior to any formal training in school.

The investigators felt that it would be important to determine if there were any significant differences in the ability of children from different environments to make visual discriminations. An F-value of 12.5 with 1 and 96 degrees of freedom was obtained and is significant beyond the .01 level of confidence. Therefore, there was a significant difference in visual discrimination ability between children representing two extremes of socioeconomic groups within the district.

One of the major aspects of the problem of this study was as follows: Will those kindergarten students who are trained to make instant responses of recognition to t... letters of the alphabet show a significant difference in their visual discrimination ability from those kindergarten students who did not receive this training?

The visual discrimination subtests one, two, and four of the Lee-Clark Reading Readiness Test, administered as a post-test, constituted the criterion. The control variable was the visual discrimination subtests one, two, and four of the Lee-Clark Reading Readiness Test, administered as a pretest.

As previously demonstrated, there were unavoidable individual differences among members of the sample population which could influence the criterion. To provide the investigators with a means of attaining a measure of control of individual differences, analysis of covariance was used. By using the pretest scores of the Lee-Clark, some of the bias introduced by individual differences was removed. An F-value of 7.48 with 1 and 87 degrees of freedom was obtained and is significant beyond the .01 level of confidence.

The second major aspect of the problem of this study was to determine to what extent instant responses of recognition to the capital letters of the alphabet can be produced during the readiness stage prior to formal instruction in reading.

The Letter-Form-Training Criterion Test, as described earlier, was administered to all children as a pretest prior to training and as a post-test at the conclusion of the training. To test for significance of difference between the mean scores on the pre- and the post-test, analysis of variance was used. An F-value of 33.89 with 1 and 88 degrees of freedom was obtained and is significant beyond the .01 level of confidence.

Interpretations

In selecting the sample population for this study, an attempt was made to include children from different environments who represented extremes of the socioeconomic continuum within the Phoenix Elementary School District Number One. The limitations inherent in this approach were realized; nevertheless, it was demonstrated that environmental differences between the "high" and "low" socioeconomic groups did exist. Apparently, then, there is a significant difference in visual discrimination ability between these two groups entering school for the first time from different environments.

Since there was a significant difference in the ability of kindergarten students in the experimental group to make instant responses of recognition to the capital letters of the alphabet, it now seems plausible that the kindergarten children in this study were capable of learning to make these responses.

In addition to the fact that there was a significant difference in visual discrimination ability between students taught to make instant responses of recognition to the capital letters of the alphabet and those who did not receive this training, it might be assumed that learning to make these responses enhances visual discrimination ability.

However, certain limitations should be considered. While learning to make instant responses of recognition to the capital letters of the alphabet, the children were learning to attend to these stimuli and to concentrate on them. The attention-concentration factor is one that merits consideration. In order to make visual discriminations, one must attend to the things being discriminated.

While the pretest results very definitely favored those children who came from environments characterizing the upper extremes of the socioeconomic continuum within the district, the children from the lower extreme of the same continuum seemed to profit most from the training. Perhaps further investigation will find that children who do well on tests of visual discrimination ability upon entry to school will progress satisfactorily within the scope of the usual readiness programs and that those children who do not already possess the ability to a satisfactory degree would profit most from this kind of additional training.

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The Efficacy of an Auditory and a Visual Method of First Grade Reading Instruction with Auditory and Visual Learners

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MOST ATTEMPTS to individualize reading instruction in regular classrooms have focused on the pupils' varying interests and rates of learning rather than on styles of learning.

In a recent study of reading disabilities in children, de Hirsch, Jansky, and Langford (*2*) compared children's relative strengths in visual and auditory perceptual areas and concluded that teaching methods should to a large extent be determined by modality strength and weakness. Conversely, Harris (*3*) failed to find any significant association between the specific teaching method used (visual, auditory, or kinesthetic) and the presumed aptitude for that method.

The basic purpose of this study was to explore the efficacy of an auditory approach compared to that of a visual approach to first-grade reading, both when children were homogeneously grouped by preferred learning modality (auditory or visual) and when they were not so grouped.

Subjects and procedures

This study was initiated by the Highland Park, Illinois, school system as part of its program to evaluate and improve first grade reading instruction.

In the spring of the year, eight kindergarten classes were given the Detroit Group Intelligence Scale and the Metropolitan Reading Readiness Test. In addition, the Illinois Test of Psycholinguistic Abilities (ITPA) was administered to the children in four of the classes.

On the basis of these test results the children were assigned to their first grade classes. The four classes which were not administered the ITPA were designated as nonplacement classes. Two of these nonplacement classes received auditory method reading instruction, and the other two received visual method instruction. These nonplacement children were assigned to their first grade classrooms in the usual manner utilized by the school system—an informal "sorting process" in which an effort is made to have all classes heterogeneous and similar to one another on CA and IQ and to control boy/girl ratio within each class. The classes were not known to differ in any respect other than the method of reading instruction employed by the teacher. There were no significant differences among the four classes on IQ, MA, or total reading readiness.

Each child in the other four classes, the placement classes, was labeled an "auditory" or a "visual" subject on the basis of his performance on the two ITPA subtests of memory which measure automatic-sequential language abilities and have been found to correlate with reading. The total group of placement children (N=87) was stronger in auditory memory (auditory-vocal sequential, subtest No. 8), where the mean language age was 80.75 months, than in visual memory (visual-motor sequential, subtest No. 9), where the mean language age was

71.30 months. The "typical" child in this group thus scored nine months higher on auditory memory than on visual memory. The difference was used as the base line in the determination of whether a child was labeled "auditory" or "visual." If his auditory memory score exceeded his visual memory score by more than nine months, he was designated an auditory subject; if it exceeded the visual by less than nine months, he was a visual subject. There were some borderline cases which were labeled on the basis of the total profile (comprised of four additional auditory tests and three additional visual tests).

Many of the children in the auditory group showed only a very slight preference for the auditory modality, and the same was true for those in the visual group. All of the strong preference children were clearly in their appropriate group. The inclusion of "borderline" subjects has the effect of minimizing obtained differences.

Table 1 shows the constitution of all eight classes.

Figure 1 shows the mean ITPA scores of the two Placement Classes of auditory subjects (N=44) and the two Placement Classes of visual subjects (N=43). The greatest differences occur in auditory memory and visual memory since these subtests were the bases on which the children were divided. However, the auditory subjects' mean score was slightly higher on all five auditory subtests, and the visual subjects' score was higher on the four visual subtests.

The auditory method classes used the Lippincott beginning program; the visual method classes, the Scott, Foresman series. The teachers of the placement groups were not told whether they had a class of auditory or of visual subjects. (The two auditory method teachers guessed correctly which group they had within the first few weeks of school, but this fact was not confirmed for them.) All eight first grade teachers in the study attended in-service orientation sessions in which the use of only those supplementary reading materials and techniques consistent with the basic approach used in that classroom (auditory or visual) was emphasized and discussed. Only one instance of "contamination" was discovered in which a teacher of a nonplacement visual method class employed some supplementary auditory materials.

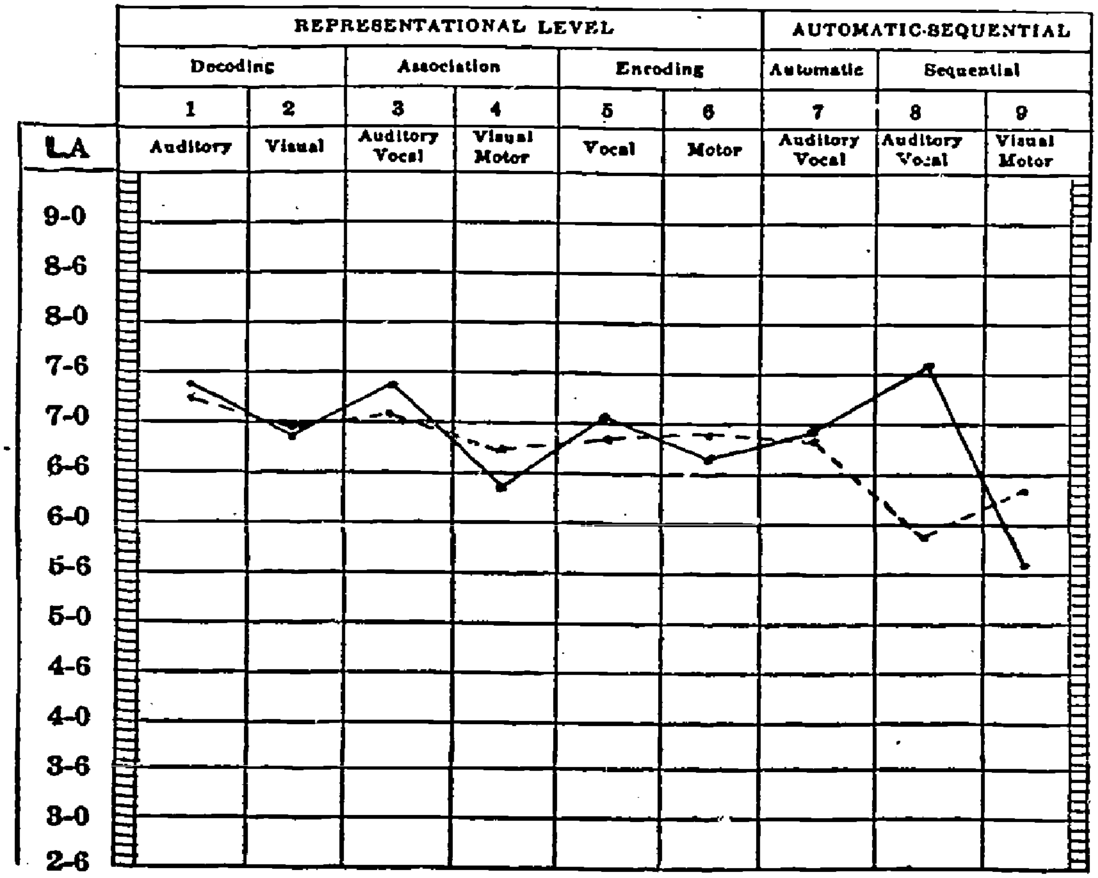
At the end of first grade the Gates Primary Word Recognition and Paragraph Reading tests were administered to all eight classes. Each pupil's scores on these two tests were averaged to obtain his reading grade. A spelling test (author-constructed) consisting of 12 words and 6 nonsense words was also administered to all subjects.

TABLE 1

EIGHT CLASSES

Placement Classes	Subjects	Method	N	$\overline{IQ}$
1 (A_sA_m)	Aud.	Aud.	24	126.0
2 (V_sA_m)	Vis.	Aud.	24	124.7
3 (A_sV_m)	Aud.	Vis.	20	124.8
4 (V_sV_m)	Vis.	Vis.	19	126.2
			87	
Nonplacement Classes				
5 (A-V_s, A_{m1})	Aud. & Vis.	Aud.	25	124.3
6 (A-V_s, A_{m2})	Aud. & Vis.	Aud.	23	127.0
7 (A-V_s, V_{m1})	Aud. & Vis.	Vis.	25	121.6
8 (A-V_s, V_{m2})	Aud. & Vis.	Vis.	22	125.6
			95	

FIGURE 1
Profile of ITPA Performance of Auditory (N = 44) & Visual (N = 43) Subjects



	1	2	3	4	5	6	7	8	9	
——— Aud.	87.8	81.5	88.2	76.5	84.6	80.4	83.4	90.9	66.9	Months
– – – – Vis.	87.0	82.4	84.7	81.1	82.7	82.8	82.7	70.6	75.7	Months

Results—nonplacement classes

The results obtained are presented in three sections: 1) a comparison of the auditory and visual methods in the nonplacement classes; 2) a comparison of the auditory and visual methods with auditory and visual subjects; and 3) a comparison of good and poor readers from the placement classes.

Summary data for the nonplacement classes are presented in Table 2.

The 2.1 point IQ difference between the combined auditory method classes (N = 48) and visual method classes

TABLE 2
NONPLACEMENT CLASSES (N = 95)
READING AND SPELLING ACHIEVEMENT

	Class				Average Reading Grade		Spelling
	N	Subjects	Method	$\overline{IQ}$	$\overline{X}$	SD	$\overline{X}$ No. Right
	25	A-V,	A_{m1}	124.3	3.34	1.14	7.04
	23	A-V,	A_{m2}	127.0	3.27	.57	6.57
Total	48	Auditory	Method	125.6	3.31	.91	6.81
	25	A-V,	V_{m1}	121.6	2.95	.51	2.88
	22	A-V,	V_{m2}	125.6	3.00	.53	2.65
Total	47	Visual	Method	123.5	2.98	.52	2.77

(N=47) was not significant. The auditory method was significantly superior ($\pm = 2.17$, $p < .05$) to the visual method. The mean reading achievement of the children in the auditory classes was 3⅓ months higher than that in the visual classes.

The difference in achievement between the two auditory classes was only a half month which was the same as the difference between the two visual classes. This finding suggests that the teacher variable was not so crucial as the method employed.

The same clear superiority of the auditory method over the visual is seen in the spelling scores as presented in Table 3.

The foregoing data reveal that when children were heterogeneously grouped without regard to preferred learning modality, the auditory method of instruction produced results significantly superior to those of the visual method in both reading and spelling.

Results—placement classes

Analysis of variance (two-way fixed effects model) of reading achievement revealed that for the four placement classes the auditory method was significantly superior to the visual method ($F = 16.28$, 1 df, $p < .01$) and that the auditory subjects were significantly superior to the visual subjects ($F = 9.28$, 1 df, $p < .01$). Method accounted for 14 percent of the variance and subjects for 7 percent. There was no interaction between subject and method ($F = 1.62$, NS). Table 4 summarizes reading and spelling achievement of the four placement classes.

The superiority of the A_sA_m group and the poorer performance of the V_sV_m group in reading are apparent.

Analysis of variance of spelling scores revealed that the auditory subjects were superior to the visual subjects ($F = 49.4$, 1 df, $p < .01$) and that the auditory method was superior to the visual method ($F = 42.7$, 1 df, $p < .01$). Method accounted for 24 percent of the variance and subjects for 28 percent. Again, there was no interaction between subject and method ($F = 2.0$, 1 df, NS).

Good readers versus poor readers

The children in the placement classes who scored at the 3.9 grade level or above were designated "good"

TABLE 3
NONPLACEMENT CLASSES
SPELLING ACHIEVEMENT

Spelling Score	Auditory Method Classes	Visual Method Classes
0-5 words right	14 (29%)	39 (83%)
6+ words right	34 (71%)	8 (17%)
N	48	47

TABLE 4
PLACEMENT CLASSES
READING AND SPELLING ACHIEVEMENT

N	Subjects	Method	$\overline{IQ}$	Average Reading Grade $\overline{X}$	SD	Spelling $\overline{X}$ No. Right
24	A	A	126.0	3.62	.37	11.29
24	V	A	124.7	3.43	.38	7.92
20	A	V	124.8	3.34	.59	7.85
	V	V	126.2	2.90	.51	1.79

readers, and those who scored below 2.9 grade level were "poor" readers. These highly arbitrary cutoffs were dictated by the necessity of choosing points which would yield groups of a size suitable for study.

Of the 16 good readers, 14 were taught by the auditory method and two by the visual method. Of the 18 poor readers, 16 were visual subjects, 12 of whom were taught by the visual method. The clear superiority of the auditory method over the visual and the less marked superiority of the auditory subjects (as found in the analysis of variance) are both apparent in Table 5.

The mean IQ of the good readers was 129.6 compared with 120.2 for the poor readers. Table 6 shows the IQ breakdown by preferred modality.

The visual subjects who were good readers were substantially above the average IQ for the total group, while the auditory subjects who were poor readers were appreciably below the group mean in intelligence. These data again confirm the earlier observation that children who prefer the visual modality are handicapped, relative to those who prefer the auditory modality in reading. An interesting possibility is suggested: Did the few visual subjects who became "good" readers by the end of first grade also become more auditorially oriented?

When the ITPA profiles of the 16 good readers and 18 poor readers were plotted (see Figure 2), it was immediately apparent that the psycholinguistic patterns were different in shape as well as in level. The level difference was to be expected since the IQ's and MA's of the good readers were higher than those of the poor readers. Because the good readers were predominantly auditory subjects (12 of 16), their highly auditory profile is not unexpected. However, the poor readers were predominantly visual subjects (13 of 18): but their profile is not predominantly visual. Figure 1 shows that the mean difference between the total group of auditory subjects and the total group of visual subjects on auditory-vocal automatic is less than one month. Yet on Figure 2 it is 15 months. Also, Figure 1 shows only a two-month superiority of the auditory subjects in vocal encoding, while the good readers (Figure 2) are 15 months higher than the poor readers. The foregoing suggests that, given good auditory memory, other auditory-vocal skills (incidental verbal learning and vocal expression) may play a more important role in reading than previous ITPA studies have indicated.

The poor readers' ITPA profile differs from their "parent" visual group in that they show a peak in motor encoding and are below the total visual group in visual memory. The low visual memory might be related to the

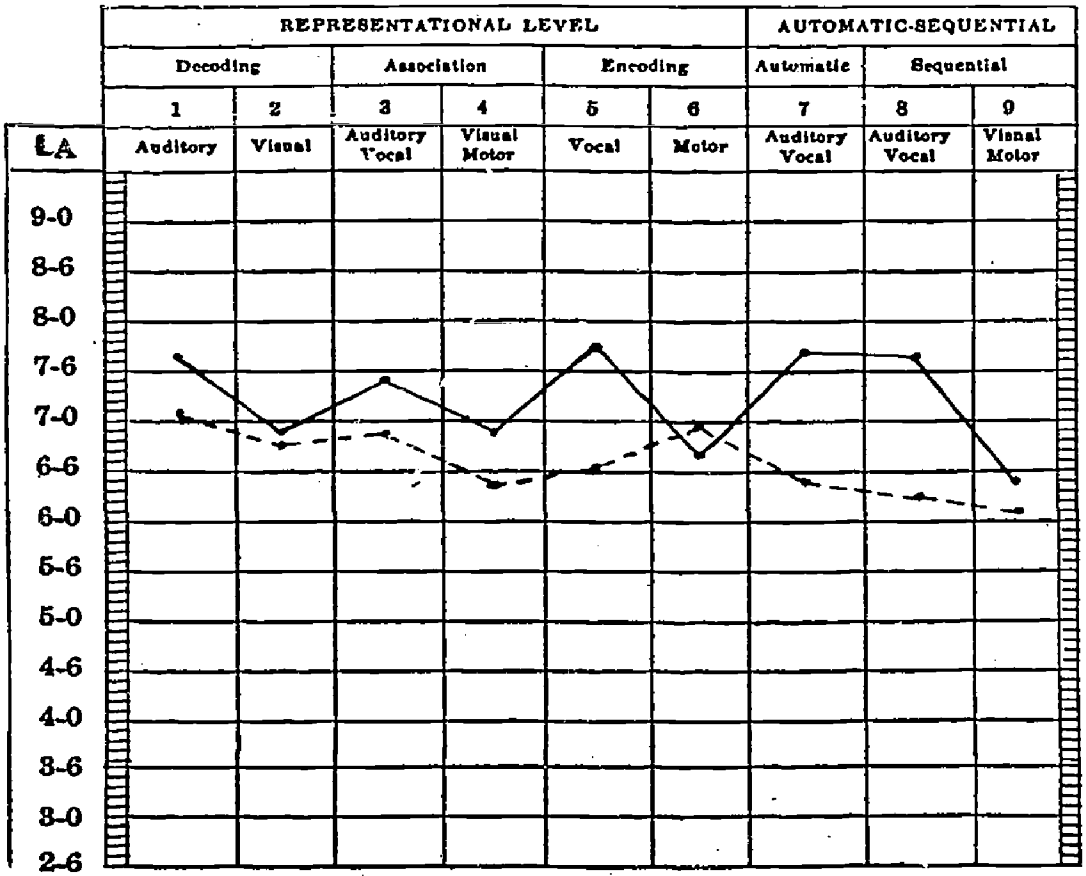
TABLE 5
CLASS PLACEMENT OF GOOD AND POOR READERS

	N	A_sA_m	A_sV_m	V_sA_m	V_sV_m	A_s	V_s	A_m	V_m
Good	16	10	2	4	0	12	4	14	2
Poor	18	1	4	1	12	5	13	2	16

TABLE 6
IQ OF GOOD AND POOR READERS

	N	A_s	V_s	T
Good	16	127.8	135.0	129.6
Poor	18	111.4	123.6	120.2

FIGURE 2
Profile of ITPA Performance of Good (N = 16) and Poor (N = 18) Readers



———	Good	16	91.6	82.8	89.2	82.6	93.1	79.8	92.5	91.9	76.8	Months
- - - -	Poor	18	84.7	81.7	82.6	79.9	78.2	83.8	77.3	75.1	73.6	Months

presence of the five auditory subjects in the poor reader group. This assumption poses a difficulty in accounting for the strong showing of the poor readers in motor encoding, which is a visual-motor test. The high motor encoding score of the poor readers does suggest that some very active (hyperactive?), "acting-out" children, may have difficulty adjusting to the auditory-vocal world of reading.

The unexpected finding that the A_sA_m group produced ten good readers and only one poor reader, while the V_sV_m group had 12 poor and not any good readers, has precluded the kind of intergroup comparisons of good and poor readers that would have been most meaningful in regard to psycholinguistic abilities.

There was no overlap whatever between the distribution of spelling scores of the good readers ($\bar{X}$ = 12.3 words correct) and the poor readers ($\bar{X}$ = 2.2 words correct).

Summary and discussion

The major findings of this study may be very simply stated: the auditory method of reading instruction was superior to the visual method for both reading and spelling; the auditory-modality-preferred subjects were superior in both reading and spelling to the visual-modality-preferred subjects; and there was no interaction between the subjects' preferred modality and the method of instruction used.

Within the fields of remedial and corrective reading one of the recurring issues centers on whether instruction should be geared to the child's pattern of cognitive strengths or to his weaknesses. It was hoped that this study might provide evidence on this point as two groups (A_sA_m and V_sV_m)

were taught in harmony with their strengths and two groups (A_sV_m and V_sA_m) according to their weaknesses. However, one of the strength groups was significantly superior (A_sA_m) to all other groups, and another (V_sV_m) was significantly inferior. The weakness groups (A_sV_m and V_sA_m) were intermediate in results produced and were highly similar to the nonplacement classes. One way to talk about these results is to say that it is not enough to ask "Should one teach to the child's strengths or his weaknesses?" but that one must specify about which child he is asking. The data from this study suggest the answer would then be to teach to his strengths if he is an auditory learner or to his weakness if he is a visual learner. However, a much simpler way of stating all this is to say that the auditory method is superior, regardless of the child's own pattern of learning.

It is, of course, possible that this method may be true for a homogeneous, above-average intelligence group, such as this, and still not be true for the extreme cases found in a reading disability population.

The close correspondence found between reading and spelling achievement was striking and possibly supportive of the observation that both reading and spelling are basically processes of making sound-symbol associations.

The findings of this study support those of Harris (*3*) who found no interaction between subject and method and those of Bliesmer and Yarborough (*1*) who compared the effectiveness of ten beginning first grade programs of reading, including Lippincott and Scott, Foresman, and found the Lippincott program was significantly superior to the Scott, Foresman on every measure of reading employed (Stanford Achievement Tests subtests of Word Reading, Paragraph Meaning, Vocabulary, Spelling, and Word Study Skills). The 484 children included in the foregoing study were from middle a[illegible]ver socioeconomic levels, in cont[illegible] the higher level of the present investigation. In the Bliesmer-Yarborough study the four "auditory methods" (including Lippincott) were all significantly superior to the three "visual methods" (including Scott, Foresman).

The evidence appears to be mounting that reading is basically a sound-symbol association process and should perhaps be taught to all children as such. The assumption has often been made by many, including the writer, that some kind of matching procedure in which instruction is differentially geared to individual children, replete with their individual differences, must be better than an arbitrary application of one method to all children. However, it is possible that our lack of knowledge of adequate or best methods of teaching a given set of behaviors such as reading has made this assumption too easy.

Limitations of the present study

One of the major limitations of this study is that the sample was drawn entirely from a high socioeconomic level. The general ability and achievement level was unusually high (e.g., only one child in the entire sample had a group IQ of below 100), and it is somewhat ironic to describe a first-grader who reads at a 2.9 grade level as a "poor" reader. However, it should not be overlooked that the major findings of this study in regard to the superiority of the auditory method have also been obtained (*1*) on low and middle socioeconomic level children.

A second major limitation appeared only when the results were available—namely, the auditory method produced only two poor readers while the visual method produced only two good readers, thus making many planned analyses impossible.

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The Relationships of Perception, Personality, Intelligence, and Grade One Reading Achievement

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MANY FACTORS, both within the child and within his environment, contribute to reading retardation. Much work has been done concerning the relationships of one or two factors with reading achievement, but few researchers have probed the simultaneous interrelationships of several factors with reading success.

Evidence suggests that at the first grade level, the prime factor in reading is word recognition, although the role of comprehension becomes increasingly more important toward the third grade as the child understands progressively longer units of sentences and paragraphs. It is therefore conjectured that a child's powers of visual and auditory perception might be more important than his intelligence for success in beginning reading. Investigators (*1, 11*) have indicated the need to test perceptual aptitudes in order to diagnose and plan remediation of reading deficiencies in word recognition.

A survey of the literature leads to the conclusion that perception is not a unitary ability but rather a composite of specialized areas which might be arranged in hierarchical levels of increasing complexity (*5, 7*). It might be further conjectured that a good pupil, even at the primary level, should have progressed toward a fairly intricate level of both visual and auditory perception. In order to identify relevant details within letters or words, he should have already reached the stages of visual analysis and synthesis suggested by Birch (*9*). Furthermore, in order to retain the results of his efforts in visual analysis and synthesis, a necessary quality to ensure success might be that of strength of closure, where the look of letters and words is held against the distraction of irrelevant visual stimuli. In this study the Marianne Frostig Developmental Test of Visual Perception was used to provide evidence of differentiation of development, particularly within the levels of visual analysis and synthesis, and of the capacity for strength of visual closure.

As with visual perception, it appears that auditory perception, is composed of different areas. Wepman (*15*) has defined three; namely, auditory acuity, auditory understanding, and auditory discrimination and retention, each of which may develop independently of the others and each of which may contribute to success in reading. It could be postulated that like visual perception there might be levels of auditory analysis and synthesis. In the present study, preliminary audiometric screening obviated the need to consider auditory acuity as a factor in reading disability. Evidence (*7*) suggests that most children possess a reasonably adequate aural vocabulary when they enter school. To ascertain whether there was a difference in this area between good and poor readers the Peabody Picture Vocabulary Test was used.

Near the end of the first grade, when a child begins to supplement his basic sight vocabulary through sound blending, it is important for him to have reached a fairly high level of auditory perception, that of increasingly fine auditory discrimination. In the present study, the Wepman Auditory Discrimination Test was used to reveal differences in development of this area between good and poor readers.

The complex relationship of personality with success in reading has been discussed at length with no clear-cut conclusions. Since Piaget (*10*) has suggested that personality, perception, and intelligence are intertwined, it might be conjectured that these factors are interrelated with one another and with reading achievement. It has been postulated that personality traits might act as attention regulators in both visual and auditory perception. If this condition were so, it might further be conjectured that personality traits could contribute to success in the more complex stages of visual and auditory analysis and synthesis, where attention is vital. In the final stages of visual and auditory perception, that of closure, when the results of analysis and synthesis are held and retained against distracting stimuli, personality traits might be the basic qualities underlying strength of both visual and auditory closure.

Malmquist (7) studied the relationship of personality and other factors to reading achievement at the primary level. An adaptation of his personality rating scale was used in the present study. Malmquist included visual perception and intelligence, but not auditory perception, among his independent variables.

The present study was planned to investigate the interrelationships of visual and auditory perception, intelligence and personality traits with reading achievement at the end of grade one, and to determine a combination of testing instruments that could be used by first grade teachers for early diagnosis and remediation of reading deficiency.

In order to determine basic perceptual and personality differences which may be responsible for differences in reading achievement, the investigator worked with two stratified samples of above- and below-average readers, who were selected from the entire population of 5,612 children completing the first grade in Edmonton, Alberta, Canada, in June 1965.

Deliberately excluded from the sample were children not in the average range of intelligence on a group intelligence test, children with below-average achievement in arithmetic, children showing major emotional disturbance, children whose home background was likely to affect their reading achievement, and children having gross physical disabilities (for example, defective vision, auditory acuity or speech) recorded on school medical cards. Individual telebinocular and audiometric screening tests were administered to check for visual and auditory defects.

The two groups were then matched on sex, school, as nearly as possible on group intelligence scores, and in 25 of the 30 pairs to the same first grade teacher. The final sample came from six schools with a gradation of socioeconomic status from lower to upper middle class classified by two independent checks.

The research design

The criterion variable, reading achievement, is the sum of the combined scores of the Edmonton Public School Word Recognition Test (Revised 1961) and the Gates Primary Paragraph Reading Test (Type P.P.R.), both tests of silent reading administered by classroom teachers as part of the regular testing program at the end of the children's first year in school in June 1965. Below-average readers are those having a combined score of between 32 and 50; above-average readers are those having a combined score of between 90 and 113.

Scores on tests of visual and auditory perception, aural vocabulary, intelligence, ratings on personality traits, and the sex of the subject are the predictor variables. Visual perception refers to the five aspects of visual perception assessed by the subtests of the Marianne Frostig Developmental Test of Visual Perception, (D.T.V.P.) namely, the abilities to coordinate hand and eye, discriminate between figure and ground, perceive constancy of shape, perceive position in space, and analyze spatial relationships. Auditory discrimination is the ability to make fine discriminations in phonemes commonly used in English speech, as assessed by the Wepman

Auditory Discrimination Test (Form 1) (W.A.D.T.). Aural vocabulary is the level of understanding the spoken word, judged by the subjects' performance on the Peabody Picture Vocabulary Test (Form B), (P.P.V.T.). The foregoing tests were administered by the investigator.

Intelligence was measured by the Stanford Binet Test (S.B.) (Form L-M) administered by graduate students of the Division of Educational Psychology, University of Alberta.

Personality ratings refer to personality traits rated on a five-point scale by classroom teacher: Concentration, which is defined as the ability to give exclusive attention to a task, to ignore perceptual distractions, and to bring one's thoughts and efforts to bear on the matter in hand; Dominance/Submissiveness, which is defined as a continuum from aggressive, commanding influence on others to unresisting, meek tractability to the will of anyone else, and Persistence, which is defined as the ability to complete a task or to overcome obstacles and surmount difficulties by a determination to succeed.

The Rating Scale of Personality Variables was adapted from Malmquist (7). Each variable is rated from one to five, and the teacher is asked to circle the numeral that represents the child's place in a heterogeneously grouped second grade class. The distribution of scores is to be based on a normal population so that in a class of 30 students, 12 to 15 would rate three, 5 to 8 would rate two of four, and not more than 3 would rate one or five. The investigator gave the teachers a careful oral explanation of each variable at the beginning of September 1965 and supplied them with a written description of each quality to be observed as follows:

Concentration 1	2	3	4	5
Exceptional ability to concentrate on assigned tasks. Never distracted by other children or activities.	Good ability to concentrate. Rarely distracted. Engages in work assigned.	Average ability to concentrate.	Easily distracted. Short attention span.	Cannot concentrate at all. Attention wanders incessantly.

Since only one teacher knew the child, there was no chance to establish reliability by a split-half method. Also such ratings were subject to the "halo" effect. This condition may be counteracted by specifying and delimiting as thoroughly as possible the variables to be rated. The observation period was eight weeks.

The data were analyzed in harmony with the two purposes of the study. The main analysis was that of multiple linear regression which gave means, standard deviations, and multiple correlations and determined the contribution of single, pairs, or triads of predictors to reading achievement, in the presence of the other independent variables. The differences between variances were tested by an F-ratio test; the difference between means was tested by the t-test, both for independent samples.

Results

1. An examination of the means and the standard deviations for the total group disclosed that the means of the D.T.V.P. subtest II and IV are close to the maximum score and that the standard deviations are small. D.T.V.P. subtest V is similarly limited but to a lesser extent. A comparison of means between good and poor readers shows no significant difference on D.T.V.P. subtest IV, with differences at the .05 level of significance on D.T.V.P. subtest II and V.

It seems evident that by the begin-

TABLE 1

CORRELATIONS OF READING ACHIEVEMENT SCORES WITH SCORES ON D.T.V.P., W.A.D.T., S.B., PERSONALITY RATINGS AND SEX

N = 60	Marianne Frostig Developmental Test of Visual Perception								Personality Ratings Derived from Malmquist				Sex
	Subtest I	Subtest II	Subtest III	Subtest IV	Subtest V	Composite Score	Wepman Test of Auditory Discrimination, Form I	Stanford-Binet Form L-M Intelligence Quotient	Concentration	Dominance/ Submissiveness	Persistence	Peabody Picture Vocabulary Test, Form B	Male
Reading Achievement	.361	.241	.445	.206	.313	.615	—.571	.536	—.696	—.557	—.577	.157	—.051
Significance Level	<.01	NS	<.01	NS	<.05	<.01	<.01	<.01	<.01	<.01	<.01	NS	NS

Correlations r > .33 exceed the .01 level of confidence
r > .26 exceed the .05 level of confidence

ning of the second grade, the ability to perceive position in space (D.T.V.P subtest IV), and to a lesser extent, the abilities to distinguish figure ground (D.T.V.P. subtest II), and to analyze spatial relationships (D.T.V.P. subtest V), had matured sufficiently in many of the 60 subjects so that those particular aspects of visual perception were no longer important factors influencing reading achievement.

The lowest coefficient of correlation of all variables with reading is that of sex. This result may be due to the design of this experiment, which required an equal number of male and female below-average readers in a specific attempt to rule out the influence of sex on reading achievement from the present investigation.

The personality rating for concentration provides the best coefficient of

TABLE 2
REGRESSION ANALYSIS USING FIVE SELECTED VARIABLES AND RESTRICTING SINGLE PREDICTORS IN TURN

Predictor	Criterion	RSQ full	RSQ re-stricted	F Ratio	Degrees of Freedom	Prob-ability
D.T.V.P. Score, in presence of W.A.D.T., S.B. Intelligence scores and concentration rating.	composite reading score	.679	.626	9.171	1/56	< .01
W.A.D.T. Score, in presence of visual composite and intelligence scores, and concentration rating.	composite reading score	.679	.632	8.037	1/56	< .01
S.B. Intelligence Score in presence of visual and auditory scores and concentration rating.	composite reading score	.679	.654	4.351	1/56	< .05
Concentration rating, in presence of visual auditory and intelligence scores.	composite	.679	.599	13.822	1/56	< .01

Coefficients of correlation between reading achievement and the other variables are shown in Table 1. All are significant at the .01 level of confidence with the exception of the three D.T.V.P. subtests II, IV, and V, the P.P.V.T., and the sex of the subject. Additional evidence is provided that the particular aspects of visual perception measured by D.T.V.P. subtests II, IV, and V, and the understanding of aural vocabulary as measured by P.P.V.T. were not major factors governing the ability to read of the 60 subjects.

correlation—.696. It should be noted that although the personality ratings and the auditory discrimination score produce correlation coefficients with minus values (except with each other), the relationship is positive since a high score indicates a poor performance.

2. Multiple linear regression equations were next constructed to predict the contribution to reading achievement of independent variables, singly, in pairs or in triads. The original regression analysis disclosed that only

two of the 15 variables, concentration and auditory discrimination, had significant F-ratios at the .05 level of probability.

In order to reduce redundancy and increase effectiveness of prediction, reading achievement was held as a function of visual perception, auditory discrimination, intelligence, and concentration.

Table 2 shows that the best single predictor for primary reading achievement is the five-point personality rating for concentration.

Table 3 discloses that the pair of variables most strongly predicting reading is a combination of visual perception, as measured by the composite D.T.V.P. score, and the concentration rating.

Table 4 shows the most . ffective triad of predictors of reading achievement to be a combination of visual and auditory perception with concentration. All possible triads secure sufficiently high F-ratios to rate probabilities beyond the .01 level of confidence.

The results of the regression analysis confirmed and extended the conclusion drawn by the comparision of means and the examination of correlation coefficients. By subtracting the multiple correlation squared (RSQ) for the restricted model from that of the full model, a decimal fraction was obtained which represented the reduction in predictive efficiency when a predictor variable was excluded in the presence of the others. This number was then converted to a percentage contribution by multiplying it by a hundred. For example, for the variable concentration, $RSQ_f - RSQ_r = .7321 - .6938 = .0793$. Therefore,

TABLE 3

REGRESSION ANALYSIS RESTRICTING COMBINATIONS OF TWO VARIABLES IN TURN FROM THE FOUR SELECTED PREDICTORS OF PRIMARY READING

Predictor	Criterion	RSQ full	RSQ restricted	F Ratio	Degrees of Freedom	Probability
D.T.V.P. and W.A.D.T. Scores, in presence of intelligence and concentration.	composite reading score	.679	.574	9.124	2/56	< .01
D.T.V.P. and S.B. Intelligence Scores, in presence of visual perception and concentration.	composite reading score	.679	.571	9.401	2/56	< .01
D.T.V.P. Score and Concentration Rating, in presence of visual perception and intelligence.	composite reading score	.679	.470	18.138	2/56	< .01
W.A.D.T. and S.B. Intelligence Scores, in presence of visual perception and concentration.	composite reading score	.679	.589	7.821	2/56	< .01
W.A.D.T. Score and Concentration Rating, in presence of visual perception and intelligence.	composite reading score	.679	.502	15.398	2/56	< .01

TABLE 4

REGRESSION ANALYSIS RESTRICTING COMBINATIONS OF THREE VARIABLES IN TURN FROM THE FOUR SELECTED PREDICTORS OF PRIMARY READING

Predictor	Criterion	RSQ full	RSQ re-stricted	Differ-ence	F Ratio	Degrees of Freedom	Prob-ability
D.T.V.P., W.A.D.T. and S.B. Intelligence Scores, in presence of concentration.	composite reading score	.679	.484	.194	11.282	3/56	< .01
D.T.V.P., W.A.D.T. Scores and Concentration Rating, in presence of intelligence.	composite reading score	.679	.321	.358	20.759	3/56	< .01
W.A.D.T., S.B. Intelligence Scores and Concentration Rating, in presence of visual perception.	composite reading score	.679	.408	.270	15.700	3/56	< .01

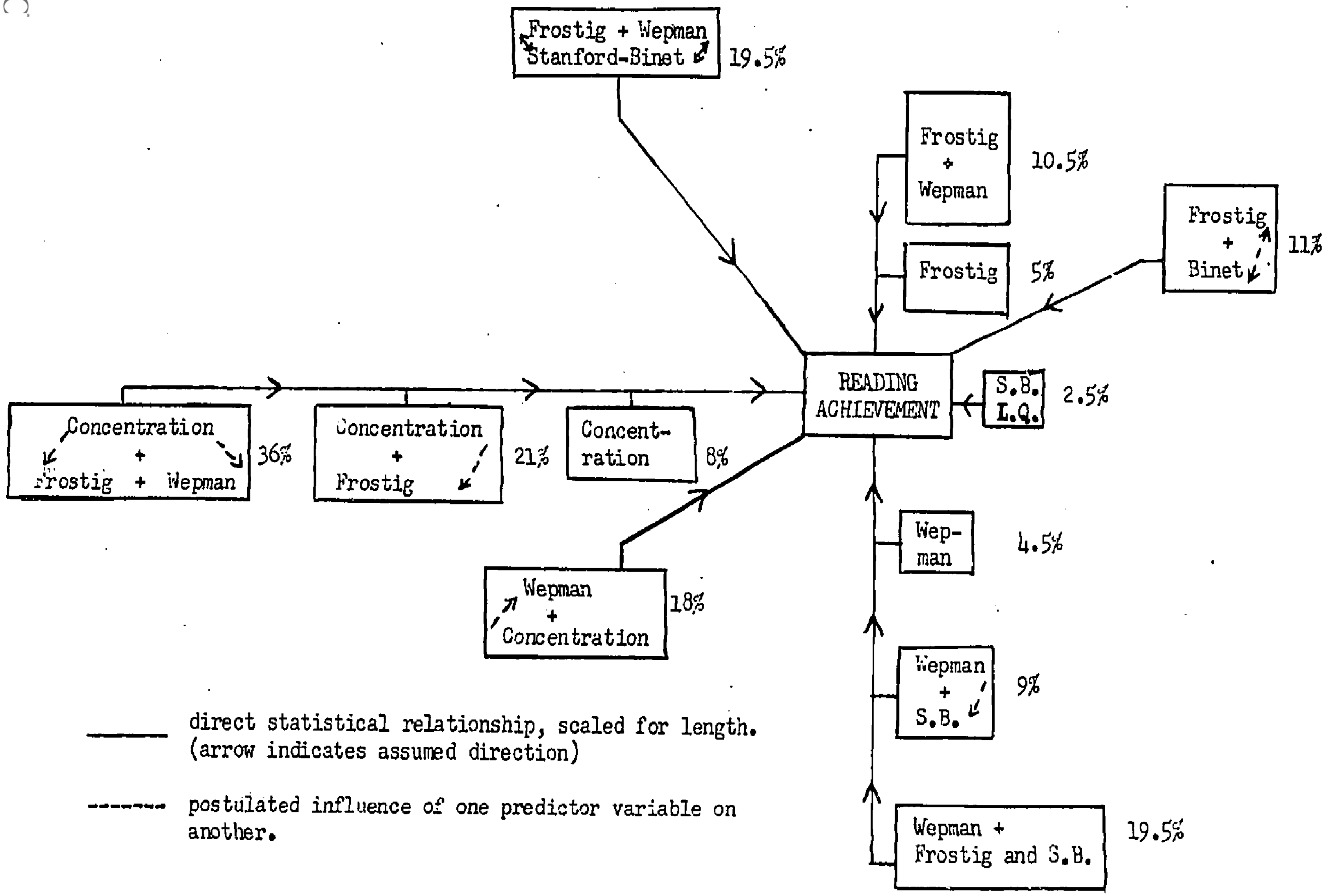
when the last decimal figure was rounded off, the variable concentration alone contributed eight percent of the variance in reading achievement.

By restricting pairs of independent variables, the percentage contribution of two predictors could be computed, and similarly for three variables taken together.

By adding the composite D.T.V.P. score to the concentration rating, the predictive value rose to 21 percent, and the further inclusion of the W.A.D.T. scores to 36 percent. These three produced the highest percentage of the total variance in reading achievement that could be predicted from the independent variables used in this study.

To what then, could the remaining 64 percent of variance be attributed? First, it should be noted that intelligence was excluded from the predictor battery. The inclusion of this variable would no doubt considerably reduce the proportion of unattributed variance. Intercorrelations between the chosen variables contributed some of the remaining 64 percent of the variance. The simultaneous restriction of three variables produced a greater increase in predictive power than the sum of the contributions of the three variables taken separately. Apparently, by combining the effects of two or three predictors, the effect of intercorrelation was reduced and the predictive value increased. It would not be unreasonable to postulate, for example, that an ability to concentrate would enhance performance on tests of visual and auditory perception or that high ability in perception and concentration would correlate well with performance on intelligence tests. Nevertheless, a considerable proportion of the variance was not accounted for. Figure 1 illustrates the logical and statistical relationship of the four predictor variables to reading achievement. The cumulative effect of combining two and three predictors is shown by plotting the variables to scale on one vector.

Other factors that might contribute to the unaccounted proportion of variance could be socioeconomic status, the cultural level of the home, the affection displayed by the parents, the child's position in the family, and the child's



——— direct statistical relationship, scaled for length. (arrow indicates assumed direction)

-------- postulated influence of one predictor variable on another.

FIGURE 1

LOGICAL AND STATISTICAL RELATIONSHIP OF VARIABLES TO READING ACHIEVEMENT emotional stability. Few of these can be easily assessed by the school, and perhaps their evaluation should be left to clinicians dealing with severe cases of reading disability.

Conclusions

The following conclusions were drawn:

1. Above-average readers differ from below-average readers in many respects: in levels of certain aspects of visual perception; in levels of auditory discrimination and intelligence; in measures of three personality traits; but not in aural vocabulary. The findings of the present study agree with those of Malmquist (*8*) who reported that at the end of the first year in school differences in many factors are already evident in good, medium, and poor readers.

2. When, however, children are in the average range of intelligence and possess no speech defect, their level of aural vocabulary is not a significant factor governing their ability to learn to read. This conclusion is in agreement with that of Harrington (*7*) who suggested that most children come to school with a sufficiently adequate aural vocabulary to begin reading.

3. Examination of the means and standard deviations of each D.T.V.P. subtest point to the conclusion previously advanced by Malmquist (*8*) that visual perception is not a unitary ability, but rather composed of different aspects or specialized areas. Vernon (*14*) suggested that development in different areas may proceed at different paces and vary according to the difficulty of material perceived. Evidence from the means and standard variations confirm Vernon's opinion. By the end of grade 1, a successful reader has attained a fairly complex level of discrimination and can hold a figure against distraction.

4. Intelligence appears to be significantly related, though less than visual and auditory perception and personality traits, with primary reading achievement. The majority of investigators into factors influencing reading achievement at the end of grade 1 have employed group intelligence measures with varying results.

The investigation which can most easily be compared with the present study is that of Malmquist (*8*). He reported coefficients of correlations between intelligence and silent reading that were positive (.50 and .42), but not so high as in the present study (.536). A general trend apparent in the research, into which the present investigation seems to fit, is that at the end of the first grade, a child's intelligence may be a significant factor governing how he reads, but there are many other factors which may have greater significance.

5. Good readers differ from poor readers in personality traits. While all three traits—concentration, dominance-submissiveness, and persistence—have very high coefficients of correlation with reading, the rating for concentration yielded the highest coefficient with reading of any variable in the study. These findings are compatible with those of Malmquist (*8*) who reported coefficients of correlation of a slightly less magnitude.

Further evidence of the strength of the concentration trait is demonstrated by its coefficients of correlation with visual perception, intelligence, and auditory discrimination. Auditory discrimination appears to be relatively more independent of concentration than visual perception and intelligence, but this finding may be due to the brevity of the Wepman Auditory Discrimination Test compared with the longer visual and intellectual batteries. Even so, concentration has a significant relationship with auditory discrimination; and it might be speculated that like visual perception, auditory perception may have levels of analysis and synthesis and particularly require strength of closure where the memory of a sound must be held against distraction; for as Vernon has suggested, it is vital to attend, for "auditory stimuli, once lost, are gone forever." (*13*: 61).

Caution must be exercised, however, when the value of the personality factors is considered, as they were measured by the teacher's ratings which are of necessity subjective, likely to be influenced by halo effects, sex bias, or prejudice. Furthermore, there appears to be no satisfactory way to test reliability or validity of this measure.

Finally, multiple regression analysis demonstrated that a battery of tests rather than one single measure best predicts primary reading achievement. In this investigation a combination of The Marianne Frostig Developmental Test of Visual Perception, the Wepman Auditory Discrimination Test, and a teacher's rating for a personality trait—concentration—provided the best prediction for the end of the first grade reading score. The evidence from the present study shows that if a measure of concentration rather than a measure of individual intelligence is combined with visual and auditory perceptual scores, a better prediction of reading is achieved.

Limitations of the study

The limitations of the study include the following:

1. The population from which the sample for this study was selected consisted of the grade 1 students. The sample was not randomly selected from the available population. Because an attempt was being made to study some of the factors affecting reading achievement, restrictions were placed on the selection of the sample with the aim of reducing the effect of other variables. Pupils selected were matched in respect to sex, school, freedom from gross physical and emotional handicaps, as nearly as possible to group intelligence scores, and in 25 of 30 pairs to the same first grade teacher.

2. The selected sample was stratified with respect to reading achievement. Consideration of the means and standard deviations of all other variables indicate that these were normally distributed.

3. A preliminary attempt was made to reduce the correlation of intelligence with reading achievement by restricting the population to the normal range of intelligence, 90 to 120 IQ, as measured on the Detroit Beginners Intelligence Test. Subsequent individual Stanford Binet ratings considerably extended the range of intelligence scores.

4. The discriminatory power of The Marianne Frostig Developmental Test of Visual Perception, particularly with respect to subtests II, IV, and V, appears to diminish with increasing age. Its peak of effectiveness is probably reached at the beginning of the first grade.

Implications

Based upon the findings of the study, the following implications appear tenable:

1. Preliminary eye and ear screening revealed that approximately one in every 11 potential subjects had a hearing deficiency while one in every 9 had a visual defect, all previously undetected. Improved visual screening and an individual audiometric check in first grade might lead to fewer learning problems.

2. Two aspects of visual perception appear very important to success in end of first grade reading. It might be conjectured from the findings of the D.T.V.P. subtests that by the age of seven almost all children in the average range of intelligence have progressed through the first stage of simple visual discrimination and the majority through the second stage, that of visual closure, where good readers emerge as significantly superior to poor readers. Exercises to encourage visual memory might be more beneficial than the simple matching exercises commonly found in primary workbooks.

3. The second aspect of visual perception which appears to have matured in good readers but not in poor ones is that of eye-motor coordination. It is easier to see a direct link between eye-motor coordination and handwriting rather than reading. Perhaps poor eye-motor coordination is a symptom of a general immaturity of fine neurological integrations, one form of which

must be used for reading. It might also be conjectured, as de Hirsch (2) did, that maturity comes through increasingly finer and more complex integration of neural systems. It might then be implied that muscular coordination should be viewed as a continuum extending from gross to increasingly finer coordination, and that additional measures to test gross coordination be used if eye-hand coordination is shown to be defective, so that specific remediation may take place at the level of need.

4. It has been shown that the Wepman Auditory Discrimination Test differentiates between good and poor readers at the end of the first grade. In the present study it appears that children who can read well have already reached a fairly complex level of auditory discrimination. Since Wepman's test measures only short-term retention, it might be advantageous to supplement this test with further measures to assess auditory memory, including strength of auditory closure.

It is further suggested that it might be possible to modify the Wepman Auditory Discrimination Test for administration with small groups by means of a clearly designed answer sheet and the use of a tape recorder which would probably increase test reliability and preserve fidelity of sound. In this way children with potential reading problems might be identified during the first grade by the teacher and given remediation through graded listening exercises at this early stage.

5. The ability to concentrate has been shown to correlate highly not only with reading achievement but also with visual and auditory perception and intelligence. It might be implied that the inclusion of many informal games to improve concentration in the primary program might produce not only better reading but also an all-round improvement in mental alertness in all subjects. These games would stress intensive visual or auditory attention at first for very short periods of time which would gradually be lengthened.

6. Teachers' ratings of personality characteristics correlate very highly with reading achievement. It seems possible that teacher observations over a period of time, guided by carefully constructed check lists and recorded on well-structured rating scales, might give more valid assessments of progress in reading than reliance on scores of group tests which are only records of isolated observations.

The findings of this study are now being tested with a larger population in which reading achievement is normally distributed.

Summary

The present investigation examined the interrelationships of visual and auditory perceptual, intellectual, and personality factors with primary reading achievement. Few investigators have studied the relative contribution of several factors to reading achievement through the technique of multiple linear regression analysis. Only one other investigator (Malmquist, 1958) has considered the relationship of personality and perception with primary reading, but he did not include auditory discrimination with visual perception as was done in the present study. Significant relationships were found between perceptual, intellectual, and personality and reading achievement at the end of grade one. A battery consisting of The Marianne Frostig Developmental Test of Visual Perception, the Wepman Auditory Discrimination Test, and a teacher's rating for personality traits, particularly concentration, would seem to have merit for diagnosing perceptual and personality weaknesses which might underlie primary reading deficiencies. These measures could be used by classroom teachers, and point the way to specific and speedy remediation.

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APPLICATION OF RESEARCH FINDINGS TO PRACTICE

Applying Research Findings in Word Perception to Classroom Practice

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RESEARCH IN the area of word recognition generally uses subjects from the primary grades. Where older pupils are involved in word recognition investigations, the research tends tc be concerned with methods and/or materials for use with remedial readers.

How one teaches reading depends upon how one defines reading. Word recognition is the process of producing the sounds represented by the printed symbols and putting them together into words. Sometimes it is called "identification," "decoding," or "breaking the code." However, word recognition is only the initial step if one considers reading to be the process of getting meaning and understanding from printed symbols. In completing the reading act the individual reacts to the material and integrates what he has read with what he already knows. In this way, his ideas and attitudes change and his intellectual growth continues.

Preschool reading experiences related to word perception

A few years ago, a popular women's magazine published an article on teaching one's baby to read and suggested this procedure might be started with two-year-olds; educators were alternately annoyed, appalled, and amused. This "system" began with teaching recognition of large letters in isolation. The idea was not really new as many generations of children have played with blocks that had letters, words, and pictures on their sides. Others have had cutout letters of wood or plastic with which to experiment and perhaps build words.

Montessori's methods, popular about 1915 and now enjoying a revival of interest, included teaching the young child to recognize, name, sound, and even write the letters of the alphabet.

O. K. Moore of Harvard has been interested in the past ten years in teaching three- and four-year-olds to read by the use of automated typewriters. His hypothesis is that early reading experiences are beneficial for children's general intellectual development. In what Moore calls a "Responsive Environment," the child first explores the typewriter and learns letters. When he strikes a typewriter key, the automated machine calls out the name of the letter or the symbol that was struck. In this way, he learns the names of the letters and what they look like. Later a teacher guides him in learning to reproduce on the electric typewriter individual letters that appear on a television-like screen before him. Finally, he types words and sentences. The idea of using typewriters with young children is not new, as experiments using regular typewriters in first grade classes were conducted at the University of Missouri in the early 1930's.

A study initiated in the Denver Public Schools was designed to show parents how to provide reading readiness activities for preschool children. *Preparing Your Child for Reading* was the guidebook used in conjunction with sixteen TV programs which elaborated on specific techniques that parents might use. These children were studied over a five-year period; the early reading experience appeared to have a positive and continuing effect.

Developing word perception skills in the kindergarten

Since about 1955 there have been several studies concerned with the reading of kindergarten children. Investigators found that, compared with the preceding generation, five-year-olds today 1) have larger vocabularies; 2) do more reading of signs and labels; 3) use longer sentences; 4) use more complex sentence structures; 5) have traveled more; 6) have had more experience with books and records; 7) have more often had nursery school experience; 8) have substituted TV viewing for the radio listening of their parents as children; and 9) have vocabularies that are different in content.

Durkin (*6*) studied the progress of 49 Oakland, California, children who learned to read at home before entering the first grade of a public school. At the end of five years she reported that the majority of these preschool readers continued to be superior readers as they advanced in school. However, these pupils were described as 1) children who wanted to learn to read; 2) children who had many opportunities to do so; and 3) children who had favorable attitudes toward reading. Durkin pointed out that her findings do not necessarily support the proposal for earlier school instruction in reading.

Since 1960 the Denver Public Schools have been conducting a pilot study involving about 4,000 kindergarteners. The subjects received systematic instruction in beginning reading. Reading tests administered at the end of first grade showed that there was a significant difference in favor of the experimental group over the control group of children who had participated in the regular kindergarten program. Optimum reading achievement occurred when the first grade program was altered to take advantage of gains the child had made in kindergarten (*3*). The study also showed that the early reading instruction created no special problems related to vision, hearing, or social or academic adjustment.

How do such pre-first grade reading experiences affect classroom practice in Grade One? The teacher finds a wider range of individual differences; some children do not need the conventional readiness program; grouping may be more difficult, requiring special flexibility; and placing each child in the most appropriate reading material may create problems because the teacher must evaluate the child's reading background with great accuracy and locate the appropriate reading materials. These changes must be reflected in the reading curriculum of all of the primary and even the later grades.

Word perception in grade one

The Chall Research. The most thorough recent study of the research on beginning reading instruction was reported by Chall (*4*) as an outgrowth of the City College-Carnegie Reading Study (1962-1965). She considered much of the research from 1910 to 1965 from several sources: the experimental research from classroom and laboratory; the findings from correlational studies; and the evidence from several well-known clinical studies of children who have failed to learn to read. Space here does not permit a discussion of her methods, but her point of view should be noted. She suggested that the first step in learning to read one's native language is learning the printed code for speech. This method agrees with Bloomfield's conclusion which may be said to represent the linguist's approach to initial reading instruction. However, Chall reported her analysis did not prove or disprove that any one method of code emphasis, i.e., linguistic approach, modified alphabets, or systematic phonics, was significantly superior to another. She commented that there is some experimental evidence that children of below-average and average intelligence and children of lower socioeconomic background do better with an early code emphasis. Brighter children and those with better socioeconomic backgrounds appear able to "break" much of the code independently, regardless of the methods used in the school reading program.

The U. S. Office of Education First Grade Reading Studies. In the school year 1964-65, 27 first grade reading studies were begun, all sponsored by the U. S. Office of Education. All used some of the same pretests and post-tests. All continued for approximately 140 school days. Bond, general coordinator, met three times during the year with all directors at the Coordinating Center for the Cooperative Research Program in First Grade Reading Instruction at the University of Minnesota. The center served two functions: to maintain communication among project directors and to collect, organize, analyze, and interpret the common data from the projects.

The studies were made in 16 different states: five were done in Pennsylvania; three, in California; and three, in New York. Except for Florida and North Carolina, no studies were done in the South.

Twenty of the studies explored the effectiveness of different methods of teaching reading or developing readiness. Two of these used Spanish-speaking children as subjects; one used the disadvantaged in a large city, and one used the low reading group. Other research examined problems related to an analysis of the interactions of professed methods, teacher implementation, and child background; a longitudinal readiness program; a comparison of two methods of reading supervision; the effects of an intensive in-service program on teacher classroom behavior and pupil reading achievement; the reading achievement of first grade boys versus first grade girls; and a comparison of beginning reading in three classroom organizational patterns.

Stauffer (*10*) commented on the studies in the May 1966, issue of *The Reading Teacher* that "No one method can be compared with another because the methods were not sharply and clearly different. For example: all taught the alphabet; all used writing experiences; and so on. Methods that were given the same label were often not the same. . . . Reading instruction time could not be defined so as to be acceptable to all twenty-seven studies. Much effort was devoted to an attempt to define reading instruction time at the Coordinating Center meeting, but to no avail."

Bond (*1*) made four tentative observations at the end of the first year of these studies:

1. There is no one method that is so outstanding that it should be used to the exclusion of the others.
2. The effectiveness of any one approach appears to be increased when it is broadened by the addition of other instructional components. For example, a basic program's effectiveness is increased when writing experiences are added, or a phonetic approach appears to profit from the addition of audio and visual instructional aids.
3. Specific approaches to first grade reading instruction appeared to increase children's achievement in certain instructional outcomes but are weak in other outcomes. Another method may develop different patterns of growth. This observation gives hope to the possibility that combinations of approaches that will encourage overall balanced reading growth will be found.
4. There was greater variation between the teachers within the methods than there was between the methods. This finding again points up the importance of the teacher's role in learning. This latter point raises the important issue as to whether the methods debate is not an artifact and that the teacher should receive major consideration.

The U. S. Office of Education extended fourteen of the studies through the second and third grades. Such continued investigations should be especially valuable since one of the great weaknesses of general research in reading has been that too often it was characterized by a proliferation of bits and pieces looked at in isolation rather than as a part of the sequential development of the individual's reading pattern.

Phonics. Over the past thirty years probably more research in reading has attacked the problem of phonics—when? and how much?—than any other phase of the reading process. It is almost impossible to isolate completely the teaching of phonics from other parts of the first grade program.

Even where the program begins with formal phonics materials, the child comes in contact with many books and oral language experiences, so phonics can hardly be considered in isolation. Teachers also know more about the various programs in phonics than they do about any other area.

In the past four years, two basal reading programs with heavy phonics emphasis have been published. Children begin with letters and sounds, and one series presents stories only after a wealth of phonics materials has been mastered. One of the results of strong interest in phonics has been the strengthening of this material in all of the well-known basal readers.

The Modified Alphabets. There has been much interest in the past seven years in the use of modified alphabets to teach word recognition skills. The best known of these are the Initial Teaching Alphabet (i.t.a.), Unifon, and the Diacritical Marking System (DMS). All of these "systems" are too new to have conclusive research about them. A special problem has been created by school systems that have rushed to use them without developing a thoughtful, careful experimental design which will make the results meaningful to other educators.

In four of the U. S. Office of Education Studies which evaluate the i.t.a. medium, conclusions ranged from a) no difference from other methods tested; b) results not always consistent; c) inconclusive at the end of grade one; and d) to use in combination with other materials.

Other studies of i.t.a., those of Bosma and Farrow (*2*), Mazurkiewicz (*9*), and Downing and Jones (*5*), generally favored the i.t.a. group.

Experiments using Unifon have been carried on in the Chicago city schools, some of the Chicago suburban schools, in the St. Louis area, and in Detroit.

Word Perception and Linguistic Approach to Teaching Reading. The linguists believe that children should be taught the "decoding system" by first learning those words that are spelled regularly as *fat, pat, mat, sat.* Oral reading should be stressed in the initial stages, and often materials at this level have no illustrations. When a child does not recognize a word, he is usually taught to spell it rather than to "sound it out."

There are several linguistic series now published, and research is just beginning on the effectiveness of this approach.

Other Methods of Teaching Word Perception. New materials for teaching word perception are appearing with great rapidity at the moment. Little or no research related to their classroom use now exists. Programed learning has been developed for beginning readers; computer-assisted instruction in initial reading is being experimented with in California; a great variety of new teaching machines are on the market; audiovisual materials are abundant and are specifically designed into several of the experimental programs.

Comparison of Methods of Teaching Reading. In 1961 Van Allen (*12*) reported a three-year study, "Three Approaches to the Teaching of Reading," that had been carried on in the San Diego area. The hypothesis was as follows: There are numerous effective ways of teaching reading in our schools. Three methods were compared: the basic reading, the individualized, and the language-experience approach. Each teacher who participated selected the approach he understood—one for which he had materials to carry it out—and received a supportive in-service program. The hypothesis, as judged by observations and test results, was confirmed. The other findings included the following: 1) language-experience teachers who ruled out all other approaches found that their children made as much or more progress in the skills (measured on standardized reading tests) as did the children who had direct teaching skills; 2) there is a closer relationship between phonics and writing than between phonics and reading; 3) many teachers are now dealing with basic sight vocabulary on an individual basis —from oral language to written language to recall of written language (this practice usually results in recognition of high frequency words as a result of repetition); and 4) each child gradually gains a personally tailored sight vocabulary which is functional and which is in excess of words introduced in the controlled programs. Control becomes an individual matter. Ceilings are lifted for all children at all grade levels.

An elaborate study of reading methods is being carried on in the Detroit public schools in which five widely different methods are being compared. These include McGraw-Hills' *Programmed Reading*, the *Ginn Basic Readers*, Lippincott's *Basic Reading Program*, Unifon, i.t.a., and Harper and Row's *Linguistic Readders*. One criticism of this study is that Unifon was developed as a permanent spelling reform, not as an alphabet for teaching beginning reading. For this reason it is not especially designed, as is i.t.a., for making the transition to the conventional English alphabet. The findings of the Detroit study, which was begun in 1965 and will extend until 1968, should be especially useful.

Fry's (*7*) study compared his Diacritical Marking System (DMS) with the Initial Teaching Alphabet and the Sheldon readers (Allyn and Bacon) in traditional orthography. Among Fry's findings were the following: 1) there was no statistically significant difference between the mean scores of any of the subtests of the post-test (Stanford Achievement) for any of the three groups; 2) there were no significant differences on the Gilmore Oral Reading Test scores; 3) no method was better for boys or girls or better for younger first graders or for older first graders; 4) the variation between classrooms was much greater than the variation between methods; and 5) the best predictor for reading achievement was IQ raw score (M.A.). Fry also concluded that reading readiness materials are not necessary in the first grade. This opinion was based on the finding that four traditional orthography project classes that did not use reading readiness materials but began reading instruction immediately after entering first grade did significantly better at December testing on the Instant Word Recognition Test than four nonproject T.O. classes that had some formal readiness instruction. The value of readiness instruction cannot be based on the results from such a small sample; however, some of the linguists agree that readiness materials are not essential.

Summary and conclusions

As a classroom teacher, how does one translate research findings into classroom practice? 1) Check the relationship of the research findings to one's own school and/or classroom objectives in the area of word perception. 2) Be slow to abandon present methods if *objective* evidence exists that the program is successful in one's particular situation with particular pupils. 3) Be slow to move into a word perception program on which little or no research has been reported unless engaged in evaluating the program oneself. 4) Reevaluate the readiness program in terms of its content and its flexibility in providing for individual differences. 5) Reconsider the phonics program. (Decide how to handle the alphabet. Decide on the appropriateness of the order of teaching decoding skills. Check methods of integrating phonics skills with the rest of the word perception program.) 6) Reevaluate the materials in use. (Are these the best available for reaching objectives? Are newer publications superior? Would certain audiovisual equipment be more efficient?) and 7) If a new program is to be instigated, carefully study the theory upon which it is based as well as the materials to be used.

The conscientious teacher of reading may find comfort in Woodring's comments (*13*) on the proliferation of methods for teaching reading.

> There is no one correct or sound method of learning to read. Successful teachers have always employed a variety of methods, children have learned to read in many different ways, and many

bright children can read before they enter school. Enthusiasts for any one of the many systems which they themselves invented can demonstrate remarkable results with their own children in their own classrooms because any of several methods will yield good results when used by a brilliant teacher devoted to her work. It does not follow that the same system should be universally adopted because it is far from certain that it will be equally effective with the average teacher.

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Translating Research into Practice: Reading Readiness, Visual Perception, and Auditory Perception

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TRANSLATING RESEARCH into practice is the final and often neglected phase of research in reading. Although numerous research studies dealing with various aspects of reading are published yearly, very few of these make a real difference in reading instruction. The influence of most of these studies is restricted to the classrooms involved in the investigations.

How are teachers' practices in the teaching of reading influenced by research findings? What are the hazards of interpreting accurately the results of research in reading? What are some of the recommended practices growing from previous research on reading readiness, visual perception, and auditory perception? Before drawing implications from the studies reported, each of these three questions will be discussed briefly.

Research findings and teacher change

Change in practice as a result of research occurs only if teachers in some way become aware of the findings of pertinent investigations. Four ways in which teachers may learn about research results are discussed.

Teachers read research reports in professional journals and translate findings into practice. This avenue is one that might be used to bring about changes as a result of research. Despite this possibility, very little change occurs through this medium. Most teachers are not well informed in the interpretation of research results, and persons who prepare research reports are not always helpful in the way they present the results. If a teacher sees a practical application from some published research reports, he does it in spite of the researcher. The studies from which generalizations can be drawn usually are so statistically oriented that a second course in statistics is a necessity for unraveling them; most teachers do not have a first course. Teachers are much more likely to be influenced by a noncontrolled study in which some teacher tries out something in her own classroom, finds it successful with her children, and writes about it. Teachers can read these studies with understanding; whereas researchers seem to write for other researchers.

Someone reviews the literature, draws conclusions, and suggests practical implications; teachers read these and put recommendations into practice. Research reviews are published in a number of periodicals that are readily available to teachers. Most of these reviews, however, do not include implications for practice, and many of them review studies uncritically. The teacher is more likely to be influenced by this type of article than by the original research article itself. Still, the amount of influence from such reviews is likely to be small.

Writers of professional textbooks review the literature and incorporate findings in their recommendations for practice. Those preservice and inservice teachers who enroll in courses using textbooks on reading methodology may be brought into contact with translations of research findings in the way of assigned or voluntary reading. The quality of these reviews varies greatly.

Authors and editors of elementary and secondary school textbooks incorporate findings in their materials. Basal reading textbooks and their accompanying guidebooks are the major influences on elementary reading programs in America. Some, but not all, of the recommendations in guidebooks are based upon research.

The dozen or more series of basal readers now being used are not in exact agreement on the elements of a good reading program. If one were to ask those who prepare materials if their texts and instructional suggestions are based upon research, he would get an affirmative answer. That answer would be correct, to a degree. Some aspects of these programs are based upon research; some, on intelligent hunches. It becomes difficult to unravel the parts based on solid research and those based on opinions.

Those who prepare textbooks have a responsibility to study available research carefully and to incorporate sound research-based ideas in their materials. The rush with which they are faced in today's fast-moving world forces them to act before all the evidence is obtained. They may, from economic necessity, be forced into an area *before* evidence to support the move is on hand. Some of the more recent popular movements which have pressed publishers to take action before they were researched carefully are the linguistic approach, programed materials, and programs for the culturally disadvantaged.

At this point the reader probably is disturbed over the futility of getting action from the findings of reading research. Improvement in dissemination is certainly needed. Persons in reading must find effective ways of disseminating research findings to teachers. If research does not influence practice, then it serves no real purpose.

The hazards of research

The disseminator of research reports must be concerned with accuracy in reporting. A heavy burden of responsibility is placed upon persons who attempt to draw practical implications from research investigations. If the interpreter, either in speaking or in writing, attempts to draw implications for groups of people, then he is obligated to view the limitations as well as the strengths of the studies. He must act with a full knowledge of the general limitations of educational research in a school setting or in laboratory-type situations.

An educational researcher in the area of reading must face these problems:

Many perception studies are performed in laboratory-type situations that differ considerably from the classroom setting. It is relatively easy to set up a one-time teaching situation that may involve one teacher and one pupil in an isolated setting outside the classroom. Within the classroom an unreal learning task may be assigned and monitored for a short period of time. Such studies may provide clues which explain some parts of what happens in the larger setting. In interpretation, the fact that the setting was an unnatural one should be kept in mind. These are still useful studies if they are continued long enough so that the little pieces can be put together into a larger explanation of how learning occurs.

In the regular classroom, the learner, though he is unique in any characteristic one may want to consider, is usually surrounded by 25 to 30 other unique beings, all of whom at one time or another will influence his learning. His teacher is an extremely influential factor in his learning. Because of what he means to the child in an emotionally positive or negative way, the teacher can accomplish more, sometimes less, than the researcher who makes an infrequent or one-stop appearance in the classroom. Even the routine interruptions or interferences in the school day influence learning. If these are removed in a research setting, the situation is unlike the regular classroom. Interpretations must be made with the foregoing in mind.

Research cannot always be in a natural setting. The interpretation should recognize that other influencing factors were ruled out in the study and that the combination of the eliminated factors with whatever was tested might have led to different results because the global setting was changed.

Broad generalizations may be drawn from a very limited study. Often when a writer or a speaker states, "Research says . . . ," he presents a small study performed with a limited number of subjects in a particular type of setting. Sometimes he generalizes to the universe. Summaries of research that one finds in college textbooks and in professional periodicals often fall victim to this hazard.

Because of necessity and sometimes because of convenience, the researcher uses a small sample when a large sample may be needed for what he is attempting to do. His subjects may represent a very limited segment of the total population of school children. This procedure is certainly acceptable if the researcher defines his population clearly. The interpreter should keep the subjects in mind as he generalizes. What applies to culturally and economically deprived children in one place may or may not apply to those in another section. The populations may be different.

Such studies are not useless. As particular studies are replicated, the findings are put together. In almost all situations the findings may be the same or may apply only for certain categories or types of children, as the intellectually superior or the culturally advantaged.

The interpreter of research must refrain from indulging in overgeneralization. Often he may have to settle for a partial answer before action must be taken. When the foregoing happens, he should not attempt to support his action by research; he should admit that he does not know nor does anyone else at this stage.

The researcher may clothe an insignificant or poorly designed study in an elaborate statistical dress. The interpreter of research often encounters studies that attempt to answer questions which are not very important, and yet the elaborateness of the statistical treatment makes the study appear to be a vital one. The commonness of the highspeed electronic computer influences the number of such studies today. An assistant in a computer center, who has a good grasp of his own field but little knowledge of the field in which the study was undertaken, can lend to a statistically overdressed study.

The interpreter of research may draw implications for practice when such implications are of doubtful value. If a study is presented orally or in writing, the unsuspecting consumer may falsely assume that it has practical implications. This conclusion is not necessarily so.

This hazard of expecting implications when they are not there is fostered by some professional journals and by some college people who must "publish or perish." The interpreter of research can at least refrain from being tripped by this hazard. Publishing exploratory studies is important. However, they should be published as *exploratory* research and not as *definitive* studies. It is too easy to mislead, even when seemingly adequate precautions are taken.

The foregoing are just a few of the hazards of research interpretation and research implementation. Among the others that could have been included are the following:

The subjects may consciously or unconsciously respond in a certain way and thus negate the study.

The attrition rate may be exceedingly heavy in a longitudinal study.

Statistical techniques inappropriate for the purpose may be used.

Assumptions underlying the use of the statistical technique may not be met.

The level of significance may be inappropriately selected.

The researcher himself may be so dependent upon the computer that he does not know the techniques being used or how to interpret them.

An usually large sample may lead to a statistical difference when the difference is so small that it is of no practical significance.

Generalizations from research studies on auditory and visual perception

Many studies have been undertaken to investigate auditory and visual perception and their relation to reading, especially beginning reading. A few of the generally accepted findings that are research-supported are presented here.

Children show individual differences in perception. Any given group of children will vary in their perceptual development. The speed with which they can respond to varied auditory or visual stimuli will differ, and their levels of development will vary. For example, some first graders will come into school knowing how to discriminate auditorially between similar words and to recognize identical words when spoken. Others will need much practice. This generalization is a part of what the teacher means when she says, "Some children are ready to read when they enter school; some children are not."

The implication for practice is that perceptual skill teaching must be geared to the child's particular level of achievement in so far as this can be done. Further, the teacher must expect some children to increase their perceptual skills at a more rapid rate than others.

The generalization just stated is widely accepted. However, hidden beneath the generalization are some unanswered questions. To what extent are these individual differences the result of the child's preschool environment? To what extent can a modified environment help to overcome what some persons think are the results of a deprived environment? What role does the central nervous system play in individual differences in perceptual abilities? What programs are best for children who are weak in a given perceptual ability? We have partial answers to some of these questions, but much remains to be learned.

Auditory and visual perception are related to success in beginning reading. This generalization is universally accepted. All beginning reading and kindergarten programs are concerned with assessing and developing auditory and visual perception. Reading readiness tests attempt to assess the level of development of these two perceptual abilities.

The evidence from the studies which have explored the differential learning modalities of pupils is somewhat conflicting. Still other studies have investigated the effect of simultaneous audio and visual presentations of stimuli.

Some of the materials in typical reading readiness materials are not needed by most six-year-olds. Gross visual discrimination exercises are useless for many children. By the time they get into kindergarten or first grade they can make these gross discriminations. In fact, some studies have indicated that most children entering the first grade can discriminate between and match letters.

One of the best predictors of beginning reading success is the extent to which the child can name the letters. Several studies have come to this conclusion. Hidden beneath this generalization are some possible influencing factors that need investigation. Knowledge of letter names may not be the major factor in success; it may reflect the level of intelligence of the child and the attention he has received at home, both of which will influence his learning to read.

The foregoing are a few of the generalizations from research on perception in the area of reading. They have not been associated here with specific studies since they are generally accepted conclusions that have been supported by many investigations.

Research studies reported and their implications

The studies presented, though they fall within a general area, actually are separate studies and must be handled as such. Some of them deal with kindergarten and first grade children while the remainder range from second grade through junior high school.

The reader may refer to certain individual research reports in this monograph for the details of the studies. Following the name of the researcher and the title of the study will be given the study strengths and limitations and then the implications for practice. The latter will include replication of the study where applicable.

Bateman, Barbara. *The Comparative Efficacy of an Auditory and a Visual Method of First-Grade Reading Instruction with Auditory Learners and Visual Learners.* Among the strengths of this study were the careful handling of the placement of children into research groups, the in-service sessions held for participating teachers, and the very adequate discussion of study limitations.

Results must be interpreted with the following limitations in mind: the two sets of materials used in the study are not on opposite ends of the visual-auditory continuum; children in the study were considerably above average in intelligence, and the findings may not apply to other intellectual levels; no information was given about how the teachers were selected for each class; except for the extremes in the placement children, the pupils were not clearly shown to prefer one learning mode to another; and, on the section of the study dealing with "good" and "poor" readers, the poor readers were well above grade level in some instances.

The following implications for practice may be drawn from the study:

1. An approach similar to that followed by the teachers who used the "auditory" materials may have promise for teaching intellectually superior children.
2. Further studies should be undertaken to assess the extent to which the different modes of learning are important in selecting instructional techniques for use both in developmental and remedial reading.
3. Another study needs to be conducted in which a program designed to be primarily visual and another to be primarily auditory are used with visually and auditorially inclined first graders.

Faustman, Marion Neal. *Effects of Perception Training in Kindergarten on First Grade Success in Reading.* Strengths of this study include the careful selection of members of the control and experimental groups, the random assignment of teachers to the two groups, and the in-service training given to all participating teachers.

As interpretations are made, the following limitations should be kept in mind: the reader has no information on how the original 32 kindergarten classes were selected; the factors accompanying perceptual training (individualization of instruction, diagnosis of learning needs, and better opportunities for teachers to gain knowledge of child growth and development) might have favored the experimental group, aside from the actual training itself.

The following implications about practice can be drawn:

1. Visual perception can be improved through training programs, and improvement probably operates favorably on learning to read.

2. The techniques used by experimental teachers may be considered for incorporation into other kindergarten programs.

3. For well-organized kindergarten programs, a half-day program is not sufficient.

Rosen, Carl L., and Ohnmacht, Fred. *Sex Differences in the Factor Structure of Selected Readiness Measures and First Grade Reading Achievement.* Among the strengths of the study are the fact that the sample was selected with care and was of adequate size, and the related literature was interwoven at appropriate points in the discussion.

A limitation of the study is that the instructional program used was not described.

The following implications for practice can be drawn:

1. First grade teachers using standardized reading tests similar to that used in this study can obtain little information of predictive value from subtests of the Frostig and Metropolitan tests.

2. Teachers should be sensitive to perceptual disabilities in first grade children.

3. Teachers need to give attention to the development of skills like those measured by the Metropolitan subsections on word meaning, sentences, and information.

Wheelock, Warren H. *An Investigation of Visual Discrimination Training for Beginning Readers.* The sample was selected carefully, and the study was presented in a clear manner.

Interpretation must consider the following limitations: the teacher variable was not discussed; the class organizational patterns were not discussed; and degree of "highness" and "lowness" of the socioeconomic extremes was not given.

The following implications for practice may be drawn:

1. The study supports the contention that children can be taught visual discrimination in the form of letter recognition during the readiness phase of reading instruction.

2. The fact that low socioeconomic level children profit more from training suggests that these children should be helped early.

3. The children should be followed to see what happens in initial reading instruction.

4. The study needs replication as a basis for broader generalizations.

Gredler, G. R. *Performance on a Perceptual Test with Children from a Culturally Disadvantaged Background* The study was exploratory in nature.

The following limitations were noted: sample size was small; a more precise intelligence test was needed; and the discussion of results was longer than the results justified.

The study needs replication with a larger sample being used.

Otto, Wayne. *Color Cues as an Aid to Good and Poor Readers' Paired-Associate Learning.* This study was neatly designed and clearly presented. The researcher was especially cautious in drawing conclusions and generalizations.

The study was of necessity limited in scope.

The following implications can be drawn for further research:

1. The same study should be undertaken, this time with color cues being pointed out to the subjects.

2. The study should be replicated to determine if the results reflect a chance happening.

3. A similar study involving a more realistic reading task, more like those encountered in reading instruction, should be undertaken.

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