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The Relationship Of Reading Achievement To Visual And Auditory Perceptual Recall For Elementary School Pupils In A Multi-Ethnic Setting

Vicki L. Brummel Barber
University of the Pacific

THE RELATIONSHIP OF READING ACHIEVEMENT TO VISUAL AND AUDITORY PERCEPTUAL RECALL FOR ELEMENTARY SCHOOL PUPILS IN A MULTI-ETHNIC SETTING

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Vicki L. Brummel Barber

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This dissertation, written and submitted by

Victoria Brummel

is approved for recommendation to the Committee on Graduate Studies, University of the Pacific

Dean of the School or Department Chairman:

Oscar J Janis

Dissertation Committee:

Heath W Lowry Chairman

Judson L James

Bobby R Hopkins

Diane C Lorenzen

Robert D. Morman

Dated December 2, 1981

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Abstract of the Dissertation

This study was undertaken to explore the relationship between perceptual recall abilities and academic performance in the area of reading.

The nature of the perceptual recall to be examined was a digit span approach with both visual-motor and auditory-motor modalities included. The study examined the relationship between pupils' performance on a group sensory instrument, the Learning Predictor, and the pupils' standing in reading achievement of above, on, or below grade level.

A large sample of 1,011 pupils from three elementary schools in Sacramento County, California, was included within the study. Each pupil within the study was administered the Learning Predictor. Grade level, school name, sex, ethnicity, and the reading achievement level were recorded for the participating pupils.

The data gathered on individual pupils facilitated a study of the relationship of each factor to the pupils' performance on the Learning Predictor. The affect of gender, grade level, and ethnicity of a pupil was explored through an analysis of covariance and stepwise multiple regression. The relationship of reading achievement for elementary school pupils to perceptual recall functioning was examined in detail. The relationship between the two modalities of visual perceptual recall and auditory perceptual recall was also investigated.

The results of this study indicated that a significant positive relationship existed between perceptual recall skills and reading achievement for elementary school pupils. Data also established that below grade level readers have difficulty in processing both visual and auditory stimuli. The results of the study also noted that as reading achievement increased, a corresponding increase in perceptual recall skills could be found.

The data obtained support the conclusion that pupils who do process the appropriate amount of information are likely to have difficulty academically. The relationship of reading achievement was studied with both visual and auditory perceptual recall skills. Regardless of the input modality, most poor readers had difficulty processing the appropriate amount of stimuli commensurate with their age. The establishment of the positive relationship among reading achievement and visual and auditory perceptual recall skills suggests that reading may not be purely a single modality task.

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CHAPTER I

THE PROBLEM AND DEFINITIONS OF TERMS USED

For many educators, the essential concept for remedial instruction has been the identification of a pupil's strengths and weaknesses as related to the individual's ability to process visual and auditory stimuli, called modality capacity. Research in learning disabilities has often revealed conflicting data regarding the correlation of learning style disorders and academic learning problems. Much of the research has been conducted to examine the validity of the interaction between modality capacity and academic performance. Results appear to lend little empirical support for the practical wisdom and intuitive soundness of this relationship. However, the modality capacity concept continues to appeal to many educators and appears useful in many pupils' identification, assessment, instructional planning, and programming (Tarver and Dawson, 1978).

The modality capacity concept or perceptual recall refers to the ability of an individual to process visual and auditory stimuli. For instance, most adults can identify how they learn most readily. Some learn through their eyes (i.e., reading and watching), while others learn through listening. Some individuals use both learning channels and reinforce what they remember by writing it down. Others repeat what they have just seen or heard and try to remember the information by means of

sub-vocalization.

The processing of information in the human memory has been likened to the computer. The taking in of information from the environment, storage capabilities, manipulation of data, and recoding portions of the information may all be traced in both systems. Shannon and Weaver (1949) discussed the quantification of information to allow for measurable bits. Hayes and Pollack (1953) took the concept of bits and conducted experiments relating to the amount of bits an average adult could process in short-term memory. Research regarding short-term recall and span of comprehension has been conducted by many others as well. In this collective body of research, variables such as proactive interference, retroactive interference, delay factors, and partial and complete reports have been examined in relation to the short-term memory store.

Atkinson and Schiffrin's (1968 and 1971) model of the memory describes a two-store system. They depict information being gathered from the environment to the sensory store, then transferring to the short-term store, and finally to the long-term store. The model provides a theoretical framework for discussing perceptual recall. In addition, Sperling (1968) established the existence of iconic and echoic stores as they relate to visual and auditory processing.

Modality preference is not a new concept. The concept that modality preference affects the teaching of reading has been researched

in detail in recent years. Tarver and Dawson (1978) reviewed the literature produced by fifteen studies that investigated the interaction between perceptual modality preference and methods of teaching reading. The research focused upon modality capabilities and the impact upon remedial programming. The findings from these studies are reviewed in Chapter II.

Studies by Kirk (1961) and Frostig (1969) appear salient to the issue. Both researchers developed instruments which measure factors of perceptual ability. Their research relating to instrument development and significance appeared crucial for examination. In addition, other instrumentation measuring modality capabilities and perceptual recall are examined in Chapter II.

Central to this study design is the ability of the classroom teacher to identify the reading achievement of the pupil. Studies by Kottmeyer (1947) and Kermoian (1962) appear to validate this practice and support the utilization of teacher assessments.

However, overall the studies of an interaction between perceptual recall and academic performance appear inconclusive and contradictory. As a result, uncertainty appeared to exist relating to this issue and corresponding directions for remedial programming. Therefore, research was needed to provide more information for assisting education decision makers (Gagne, 1967).

This study investigated the relationship of modality capacity or perceptual recall and reading achievement through the use of a standardized group sensory instrument, the Learning Predictor. The Learning Predictor offers a digit span approach which differentiates between the digit span component and fine motor control which has generally been included in previous definitions of perception. Reading achievement levels (below grade, on grade, and above grade) were determined by the teachers of pupils administered the sensory instrument. This study focused on the establishment of a positive correlation between the low perceptual functioning and the low reading achievement for pupils in grades one through six, rather than between the high perceptual functioning and high reading achievement for pupils.

The relationships of perceptual recall with reading achievement considered two components of perceptual functioning: 1) visual perceptual recall, and 2) auditory perceptual recall. Levels of reading achievement used in the analysis were: above, on, and below grade levels. The approach provided a correlation of the middle performance, rather than only the high and low extremes. In addition, this study was conducted in a descriptive nature rather than a predictive mode.

Statement of the Problem

The Problem

The research question examined in this study focused upon the relationship between reading achievement and a.) visual perceptual recall

and b.) auditory perceptual recall. During the course of this study, the following hypotheses were investigated.

Hypotheses

1. A positive relationship exists between reading achievement and a.) visual perceptual recall and b.) auditory perceptual recall for elementary school pupils.

2. A positive relationship exists between reading achievement and visual perceptual recall when auditory perceptual recall is held constant.

3. A positive relationship exists between reading achievement and auditory perceptual recall when visual perceptual recall is held constant.

4. A positive relationship exists between grade levels for primary grades (Grades 1, 2 and 3) versus intermediate grade levels (Grades 4, 5 and 6), and visual perceptual recall when auditory perceptual recall is held constant.

5. A positive relationship exists between grade levels for primary grades (Grades 1, 2 and 3) versus intermediate grade levels (Grades 4, 5 and 6), and auditory perceptual recall when visual perceptual recall is held constant.

6. No relationship exists between visual perceptual recall and a.) sex for male versus female pupils, and b.) ethnicity for pupils of Anglo-American ethnicity versus Spanish/Mexican, Black or Asian enthnicity, when auditory perceptual recall is held constant.

7. No relationship exists between auditory perceptual recall

and a.) sex for male versus female pupils, and b.) ethnicity for pupils of Anglo-American ethnicity versus Spanish/Mexican, Black or Asian ethnicity, when visual perceptual recall is held constant.

Significance of the Study

Human learning is a complex process which involves numerous interactions. A basic skill necessary to facilitate the complicated mechanism appears to be the accurate reception of stimuli presented and the ability to express appropriate responses. This stimulus-response pattern is central to the learning process depicted in a school setting. For example, the teacher presents data through a stimulus and expects the desired response from the pupils. However, when the process breaks down for a student and the information presented becomes confusing or the expected response cannot be delivered, pupils begin to experience failure. It is tragic that this breakdown, and subsequent failure, is being experienced as early as kindergarten (Smith, 1973). Therefore, it is particularly crucial that the visual and auditory perceptual dysfunction be identified as early as possible, in order that significant intervention can be introduced and efficient processing facilitated.

The accurate reception of information by each student is an important aspect of the learning process. In addition, students in the classroom are expected to retain a sequential number of pieces of information. Often the classroom teacher gives a series of directions with the expectation that each pupil will complete the five or six instructions

in the correct order. This expectation that people "remember" sequential sets of data is not restricted to the classroom. The ability to recall a telephone number can serve as another good example. A local number consists of a three digit sequence followed by a four digit sequence. With this grouping of three and four, seven digits are recalled comfortably by the majority of our population (Loftus and Loftus, 1976).

With the seven digit capacity as an average for adult operation, it is important to investigate the variations in the recall capacity (Hayes, 1952, and Pollack, 1953). Through individual testing, a pupil's digit recall can be identified. Numerous studies have been conducted regarding this phenomenon, and are discussed in Chapter II. In addition, the pupil's digit recall has been used as one factor in measuring intelligence (Wechsler, 1958).

In a classroom setting, information appears to be consumed through the auditory and visual channels. Therefore, for school learning to occur, two major sensory organs are critical, the ear and the eye. The correct reception of information is central to school success. If the information is not received accurately, the performance of the pupil will appear skewed. Common errors in reception may include reversals, seriation confusion, digit span, perseveration, rapid closure, and discrimination errors. Each of the errors noted will cause the pupil to misrepresent the information introduced by the teacher. Difficulties in visual perception may be identified by problems in copying from the

blackboard, completing workbooks, reading, retaining math concepts, and decoding sight words. The auditory perceptual dysfunctions may become apparent through difficulty in remembering instructions, excessive talking or disruptive behaviors, inappropriate responses to lectures and poor work habits. Frequently, children with auditory function difficulties are treated as a behavior problem rather than a perceptual deficit (Smith, 1973).

Teachers determine the amount of information comprehended by measuring the output channels of vocal responses and fine or gross motor responses. However, again a student may have difficulty with the expressive modality employed. Speech difficulties or fine motor control deficits may seriously hamper a pupil's ability to perform for the teacher. As a result, performance in the perceptual channels appears preliminary to success in the academic areas.

Pupils with a deficiency in modality functioning or a limited digit span would appear to be handicapped in a classroom. If the average digit recall for a fifth grade pupil was six digits, and a particular fifth grade pupil could only process three digits successfully, pupil performance would seemingly be restricted (Frostig and Maslow, 1973). Factors of time, fatigue, and attention loss may further hamper the pupil's work.

The importance of discovering the relationship between modality

capacity and academic performance appears necessary for appropriate remedial programming. In addition, the accountability movement through recent legislation requires pupils to meet proficiency standards to graduate (Hart, 1975). This accentuates a need for early identification of pupils with learning problems and appropriate programming which may change pupil proficiency in learning. Thus, research appears critical to further examine this central principle, and to provide illumination regarding the question of interaction between perceptual recall and academic performance.

Theoretical Consequences

The completion of this study provided empirical data that indicated on a preliminary basis, a correlation of perceptual functioning in the visual and auditory channels with reading achievement. Because there appears to be little research documentation on this relationship, the data may suggest to other educators further areas of investigation and study of the hypothesized relationship. It is this investigator's view that the hypotheses offers a challenging approach to increasing our knowledge and understanding of a possible source and mechanism involved in reading difficulties.

Practical Consequences

For this study a group sensory instrument, the Learning Predictor, was administered to the sample population. The determination of a correlation between visual and auditory perceptual ability and reading

achievement supports the administration of sensory instrumentation. Additionally, the early identification of perceptual disorders may prove beneficial in the remediation of reading problems (Kirk, 1972).

The test data on the hypothesized relationship, as derived from the Learning Predictor, may also help evaluators to better determine student strengths and weaknesses. When this is done, placement decisions can be made with greater expectation that reading difficulties will be reduced after remediation of the perceptual deficits.

The resultant data may also lead to the development of specific activities, instructional materials, and exercises designed to remediate the perceptual deficiencies that are adversely affecting reading performance. The study results may also encourage the development of remediation methods and techniques for reading that consider the pupil's perceptual ability.

Delimitations to the Study

The study was conducted in elementary grade schools in the greater Sacramento area. One thousand and eleven pupils in grade levels one through six were assessed for visual and auditory perceptual recall. A group sensory instrument called the Learning Predictor was used to assess perceptual ability. Each classroom teacher was asked to report every pupil's reading achievement in relation to above, on or below grade level. Information relating to ethnicity, grade level and sex was also gathered through teacher input.

Limitations to the Study

Limitations to the study were generally confined to three areas: 1) the difficulty in assessing socio-economic information, 2) the number of examiners used to administer the Learning Predictor, and 3) the use of a group instrument. Schools included in the sample were representative of the community at large in respect to social and economic factors. However, specific data relating to social and economic factors for each pupil were not included as variables in the study. These variables may have provided relevance in regard to learning problems; however, these data were not available through the school districts or other sources. The collection and administration of testing instruments were conducted by a limited number of examiners. Each examiner was trained regarding administration and interview techniques. In this manner, inter-examiner consistency was facilitated. The Learning Predictor is a group screening instrument. As a group measurement device the following factors may affect the results: 1) the inability of the examiner to motivate the individual pupil, 2) other variables may affect the pupil's performance, and 3) the inability of the examiner to analyze a pupil's performance on a qualitative basis and applying the results to the individual (Sax, 1974).

Definition of Terms

The following definition of terms are utilized in the study:

1. Modality capacities: Those channels, neurological in nature, which allow information to be received and processed and expressed in the human organism. Included are the receptive modalities, both visual and

auditory in nature, and the expressive modality of a motor response (Smith, 1971).

2. Pattern recognition: The process of transferring information from the sensory store to the short-term store (Loftus and Loftus, 1976).

3. Sensory store: Information within the sensory store in the form of raw sensory patterns which are analyzed for meaning. Included would be all visual and auditory stimuli which the senses scan, but not necessarily all information that is provided (Loftus and Loftus, 1976).

4. Short-term store: Contains information transferred from the sensory store and that is held for up to fifteen seconds (Loftus and Loftus, 1976).

5. Iconic store: Information which enters through the eyes and goes directly into a portion of the short-term memory reserved for visual input (Sperling, 1968).

6. Ecoic store: Information which enters through the ears and goes directly into a portion of the short-term memory reserved for auditory stimuli (Sperling, 1968).

7. Psycholinguistic: The ability to perceive language symbols and translate them into a basis for behavior. Language is a system of symbols which stands for ideas, feelings and objects. Language involves more than just the production of speech; it must include the psychological foundation for this behavior, the structure of the language, and the relationship of the two. This relationship is called psycholinguistics (Kirk, 1961).

8. Perceptual recall: The number of digits or bits that a pupil can receive through visual and auditory stimuli and report back after removal of the information (Loftus and Loftus, 1976).

9. T-score: The group sensory instrument for measurement of perceptual recall converts raw scores into a T-score for comparison. A

mean of 50 with a standard deviation of 10 allows for comparison of the pupil's performance (Tarczen, 1975).

10. Reading achievement: For purposes of this study the teacher's assessment of whether a pupil is above, on, or below grade level in their reading level as demonstrated in the classroom. The above, on, or below grade levels included pupils performing at a grade placement beyond their current grade (above), within the confines of their present grade (on), or below their present grade level (below). For example, a fourth grade pupil demonstrating fifth grade reading achievement would be indicated as above grade level. The same pupil demonstrating a reading achievement level of third grade would be below grade level. Attainment of reading achievement at any point within the fourth grade would be designated as on grade level.

Summary

Modality capacity has a strong intuitive attraction to educators for use in the process of pupils' identification, assessment and instructional planning. Empirical results, however, appear to lend little support to use of the concept. This study's purpose was to investigate the specific relationship between perceptual recall and reading achievement. The research question focused upon the relationship between reading achievement, and a.) visual perceptual recall, and b.) auditory perceptual recall. Defining the relationship appears important for early identification of pupils with learning problems who must eventually meet accountability standards. If these students are to become "proficient" they must be provided programming that is specifically geared to remediate their disabilities.

CHAPTER II

REVIEW OF THE LITERATURE AND RESEARCH

Chapter II examines four major areas of material pertinent to this research study. First, is an indepth look into the history of sensory thought, from Comenius and Locke in the seventeenth century, to Rousseau and Kant, to Dewey and Montessori in the mid-twentieth century. Next is a closeup view of today's concept about how we learn, human memory, and the role that digit span capacity plays in the learning process. A review of the modality preference research and testing is included as well. Finally, Chapter II discusses the proven value of teacher ratings in assessing academic performance.

Philosophical and Historical Foundations of Sensory Thought in Education

Philosophical arguments about the question, "How do men learn?" have been approached in a variety of ways. Traditionally, the empirical school of thought is represented by the doctrine that places special importance on observation and sensory experience in obtaining knowledge. Rationalism, on the other hand, states that knowledge results from reason, totally independent of the senses.

The historical and philosophical roots of educational sensory thought, seems to begin with the scholar Comenius, whose specific ideas about empiricism are quoted often in seventeenth-century literature

(Montessori, 1973 and Saettler, 1968). While the educational philosophers noted here do not include all early scholars who dealt with sensory questions, they do appear to comprise a major sample of those great thinkers who exerted much influence in the discussion regarding the acquisition of knowledge.

John Comenius (1592-1670)

Comenius had harsh words for the school systems of his day. He felt chaos and ignorance were more predominate in schools than knowledge. Lessons were nothing more than a dull collection of spoken words, usually droned by a stuffy instructor, less often shouted by an excited one. The end results appeared to be little results at all. Children were bored and discouraged from studying. In contrast to the ineffective school lessons, the training received in normal life experiences were of obvious value. Comenius felt that since the Creator had given man reason, He must also have provided "proper food for the reason" (Dobinson, 1970). Such nourishment for human reason was flavored with infinite variety as the world's mysteries were revealed through the senses. To Comenius then, the first step in man's education was sensual cognition. In all of his works, Comenius directed attention towards objects around him in the world. He pointed out the necessity of relating sensual impressions first to people's activities and then to the learning of words.

Comenius left no doubt about his point of view concerning the source of knowledge. He states, "The organs of the senses are parts of

the body in which the animal spirit receives the objects which present themselves, namely the eye, the ear, the nostrils, the tongue, and all that is in nervie" (Sadler, 1969). He labeled the five senses the "gate-way to man's soul" (Dobinson, 1970). A "common sense doctrine," that Comenius accepted was that "there is nothing in the intellect which was not previously in the senses"(Eby, 1952). This doctrine founded the principles of method which he applied to his educational practices. Like many later writers who dealt with perception, Comenius attributed special significance to the visual image. In the hierarchy of senses, sight is sovereign, and as he says, "ocular evidence is the equivalent of proof" (Sadler, 1969).

This early scholar went on to say, "The understanding of things is an internal sight; therefore the requisites in the case of internal sight will be identical with those of external sight" (Sadler, 1969). Comenius' internal sight requisites include: "1) Perception of the actual thing as such or by another's (teacher's) explanation; 2) Due attention given by a sound mind; 3) Sufficient space of time for the perception of all parts of the thing" (Sadler, 1969).

His requisites for external sight include: 1) Light which helps the eye in grasping the thing which is to be perceived; 2) A certain distance between the object of sight and the eye; 3) A certain space of time in which all parts of the thing can be perceived (Sadler, 1969). Thus, there are immediate products of sense experience and, subsequent ideas or

images from them.

Besides stating requisites for sensual perception in general, Comenius also delineated individual senses and their interactions. He wrote that:

> Listening must constantly be supplemented by seeing, and the word of the tongue with that of the hands; what they (students) are supposed to learn must not only be told to them, so that it slips through their ears, but it should be painted as well, so as to influence imagination through the eyes ... let them learn intimately to speak up about it in words and then to express it by hand, so that they do not give up anything until it has sufficiently imbued their ears, eyes, reason, and memory (Dobinson, 1970).

To meet this end, Comenius assembled a book of pictures representing everything that makes up the world; plants, animals, peoples, industry, commerce, sanitation, etc. Each idea was represented by an image and a brief commentary in words. This was called the Orbis Sensualium Pictus and it remains unique in the history of pedagogy.

Comenius firmly believed that the main task of the primary school was to begin the training of observation skills and perception. After that the focus would be to train reasoning powers towards integrating reason with the spoken word, written word, manual and physical activity,

play, and finally, reality itself. The nursery school developed by Comenius was designed for the very young student, up to six years of age, for the purpose of developing the child's outward senses and providing practice in using those senses. He also believed that before the age of six, no child could understand the hows and whys of the world. Instead his "food for reason" was a systematic introduction to everything in daily life that could be perceived through the senses.

His passion for clarity first led him to elevate the status of the object lesson in the classroom, and then to seek visual perception aids which particularly emphasized internal and external relationships. This could best be done through pictures that he had prepared to help understanding.

Comenius had completely accepted the realist philosophy that knowledge must arise first from sense experiences. Still, that left scholars of his day asking, "What happens next after sensory perception?"

John Locke (1632-1704)

John Locke was asking the same question seventy years later. Though John Locke was influenced by Comenius' ideas, he was a scientist and physician first and an educator second. Consequently, he approached the problem of "knowing" from a different angle. This education theory that Locke developed has been called "sense empiricism".

To Locke, the human infant's mind was a "blank slate" waiting to be imprinted by every life experience. His tabular rasa theory stated that there were no innate ideas. All experiences were introduced through the senses, and nothing entered the mind in any other manner. Locke stated that, "the great source of the ideas we have, depending wholly upon our senses and derived from them to the understanding, I call Sensation" (Adamson, 1912).

Furthermore, experience itself supplies the understanding of ideas through perception of the mental operations. The mind, in reflecting and considering ideas received information from the senses to reach a conclusion.

Locke felt the source of ideas was completely individualistic, being something within every man. Therefore, it was not sense-perception that was focused always on external objects. Instead, Locke felt it more properly called "internal sense" (Adamson, 1912). "The first source of knowledge is sensation," Locke said, "and the second is reflection" (Adamson, 1912). Although he was careful to assign different names to experience, sensation and reflection, his emphasis was placed on sensation. Because of this, he is sometimes regarded as the originator of a sensationalist, rather than experiential psychology.

Locke also thought that all men were initially equal, since one blank state was much like any other, and subsequent differences were due

to personal experiences. Education then, as a positive experience, was capable of affecting unlimited reform. The often repeated principle source of teaching philosophy is found in Locke; the pupils' sense organs should be exercised in schools so that learners may follow the path marked by discoverers. Pupils should be exposed to objects and processes rather than names and words. In this respect, Locke wholly agreed with Comenius.

Jean Jacques Rousseau (1712-1778)

Rousseau took Locke's concept one step further. He endeavored not just to feed the senses, but to train them as well. Like Locke and Comenius before him, he adjusted education to fit the child's stages of mental growth. In childhood he also thought that intellect was developed only through the senses. In one of his great works, Emile, he shows how he was influenced by Locke and Comenius.

> At the commencement of life, when memory and imagination are as yet inactive, the child limits his attention to what actually affects his senses. He wants to touch and handle everything. Do not check his restlessness. This is a necessary part of his training. It is by looking, fingering, and hearing, and above all, by comparing sight and touch, that he learns to feel the heat and cold, the hardness and softness, and heaviness and lightness of bodies and to judge of their size and form and all their physical properties (Boyd, 1963).

Rousseau believed the first reason of man is a reason of the senses. Everything that enters into the human understanding comes through the senses. He stated that, "Our first masters of philosophy are our feet, our hands, and our eyes" (Boyd, 1936). Rousseau's disdain for books was evident also in his comments, "Putting books in the place of experience does not teach us to reason, only to borrow from the reason of others" (Boyd, 1936).

Since Rousseau felt that the senses were the first faculties to form and mature within people, they must also be the first to be cultivated. He saw, however, that senses were generally faculties most often neglected. While motor development would come naturally, if a child was simply left free to play and interact with his environment, the senses had to be deliberately trained. Trained not just to be increasingly sensitive, but also to discriminate between objects in order that the senses could influence judgment.

Rousseau suggested that the senses must each be trained individually, and the training must be done at a very early age since the capacity was highest then. Rousseau stated that in training senses, one must "get as much out of each one as possible, and check the impression got from one sense by the others. Measure, count, weigh, compare" (Boyd, 1936).

As the adolescent child starts reasoning, Rousseau felt that the

educator should spend less and less time on training the senses. At that point in development, the body must acquire a certain firmness. Nature's design was to let the body be strong before the mind becomes active. Sense impressions and sensory processing ability were therefore a necessary prerequisite to growing and learning.

Johann Pestalozzi (1746-1827)

Pestalozzi put Rousseau's educational theories into practice. He developed a comprehensive system of instruction based upon the beliefs that education was an experience in living, rather than a preparation for life. According to him, learning should take place through pupil activities and firsthand experiences rather than through verbal explanations or definitions. In addition, these experiences should be sequenced to be increasingly more difficult. The sequencing of activities allowed for the child's own natural development and maturation. Instead of concentration on simply acquisition of knowledge, he thought that experience itself would awaken the child's innate capacities, thereby allowing him to acquire the necessary knowledge naturally.

One of Pestalozzi's aims was to "psychologize education" so that the educator's methods would be based upon a knowledge of the individual child. Furthermore, the methods should be based upon the idea that senses are the "reservoirs of knowledge" (Saettler, 1968). Pestalozzi saw the intellectual and physical powers of each learner unfolding according to natural laws in ever widening circles of experience, with each

succeeding level of experience being mastered before the learner entered the next stage. This organic unfolding of the individual learner was to be Pestalozzi's supreme objective of instruction, which could only be accomplished by constant emphasis upon sense impressions. "The most essential point from which I start is this: sense impression of nature is the only foundation of human instruction, because it is the only true foundation of human knowledge" (Saettler, 1968).

Pestalozzi thought that the world "lies before our eyes like a sea of confused sense impressions, flowing one into the other ... the business of instruction is to remove the confusion of these sense impressions ... and to raise in us distinct ideas" (Adamson, 1931). Education may assist in removing such confusion by presenting sense impressions one by one, proceeding from the simple to the more complex.

Johann Herbart (1776-1841)

Toward the end of the century, educators had blended the philosophies of Comenius, Rousseau, and Pestalozzi into one firmly fixed conviction; that observation of the use of the senses and, in general, the consideration of the simple, concrete facts in every field of knowledge was the sure foundation upon which all right elementary education rested. This truth was the starting point of the teacher's scientific methods. But while the importance of observation was readily accepted, showing the nature, time, amount and order of observations was conspicuously absent. In short, educational practices at that day did not show how mental

assimilation could best occur. Indeed, perception was thought to be the first stage in cognition. However, Herbart recognized that apperception must be a simultaneous companion in order for the process to work.

Herbart made moral development and use of knowledge the primary aim of education. His use of historical materials to meet this end reflected the influence of his contemporary, Froebel. Unlike his predecessors, Herbart rooted his educational theory and methods in a systematic psychology of learning. His was the first modern psychology of learning to accept the tabular rasa theory of the mind presented earlier by Locke (Saettler, 1968). Not only did he negate the idea of inborn faculties as did Locke, he also denied that the mind even existed at birth. According to Herbart, minds were simple battlegrounds and storehouses of ideas (De Garmo, 1896). Ideas, he thought, had an active quality of their own.

To Herbart, all perception was apperception, or new ideas growing out of old ideas and then becoming part of a large mass. Within this apperceptive process, Herbart recognized three learning levels. The first level was mostly sense activity. The second level was one in which previously formed ideas were reproduced. The third level, or highest level, was one in which conceptual thinking or understanding occurred.

Herbart's theory of an apperceptive mass added weight to the idea of individual control in mental experience, because it overcame the

problem of disconnected perceptions, which had previously led thinkers to believe that insight was a conditioned reflex. Instead, Herbart saw insight as an active mind imposing its own coherence upon experience. Consequently, he decided that it was not so much sense perception that was wanted in education, as apperception. The senses were merely tools used to create understanding.

Immanuel Kant (1724-1804)

While Herbart fixed his attention on the production and interaction of ideas, Kant's investigation concentrated on what happened before experience. Kant's constant query was, "What mental equipment must be presupposed in order that perceiving, thinking, and willing may be possible?" (De Garmo, 1896). To Herbart, apperception was an assimilation of ideas already possessed, while the Kantian theory began with a separate synthesizing power of the mind. Kant stated that:

> The mind receives something through the senses, but proceeds to add from its own inner constitution so much that the resultant thought of the object can have no similarity to the outer object. For illustration, objects do not have color. It is our way of sensing them that adds color (Eby, 1952).

Kant's suggestion that in the perception process the observed object makes a contribution to the idea, but the mind, from its own capability makes an even more significant contribution. To Kant perception

was more than the sum total of the object and the information taken in by the senses. Furthermore, he asserted that space, time, causation, and other relationships are not outer realities, but only forms by which people experience and think things. This philosophy was termed subjective idealism. At a stroke, it wiped out the external physical universe and left only mind, thought and ideas.

Frederich Froebel (1782-1852)

The German educator, Frederich Froebel, chose to view senses as an equal part of a three sided formula; practiced senses, plus a practiced body, plus an active mind meant a well-functioning human being. In developing his theory, Froebel incorporated Pestalozzian object teaching. He contended that free self-activity directed the learner's growth and allowed active creativeness and social participation to merge each personality with the spirit of humanity. To Froebel, motor expression meant learning by doing, not through verbal communication alone.

According to Froebel, education was a continuous development produced by exercise; exercise of the limbs, of the senses, and of the mental powers. Since the mind was reached through the senses, Froebel urged that from the first, senses should be exercised as organs of the mind, and not as organs of sensuous pleasure as in animals (Bosen, 1900).

The child's surrounding touched and attracted his attention, awakened the limbs, senses, mind, and the child's inner self. Froebel

began at the earliest possible age, with the infant lying in a chaos of sensation, feeling comfort and discomfort, acceptableness and offensiveness. Within these sensations, he felt that something could be done to help or hinder the youngest child. The activities Froebel developed aided in sensory discrimination, and were implemented in the kindergarten which he established.

Froebel thought that when activities of the senses, body, and limbs were developed to a high degree, the child would begin to express the internal, outwardly. Then the stage of infancy would cease and the stage of childhood would begin.

John Dewey (1859-1952)

Towards the end of the nineteenth century, education had come nearly full circle. Dewey's belief that knowledge resulted from experience was as old as Locke. Growth consisted of experimenting with ideas, and Dewey had no time for speculating about a source of knowledge. Experience was a sufficient source of knowledge and, furthermore, the only real source of knowledge for this educator (Dewey, 1938).

Emphasis on the individual was abandoned in favor of simply providing sense experience. Dewey's education was simply a reconstruction of experience in which the teacher provided stimulation for thinking and common experiences for the student. At this point, the teacher had done all that could be done in educating the student (Dewey, 1938).

Dewey's influence was strong. His emphasis on "learning by doing" moved stress from the stimulus to the response and took the whole of education with him.

Maria Montessori (1870-1952)

Not long after Dewey changed the face of education, another philosopher rethought an old idea and founded a new theory. Montessori's aim was, "to revive the idea of Comenius, bringing the world itself to the child" (Montessori, 1973). Montessori stated, however, that ideas lost strength and, in fact, may be weakened by a teacher who pictorializes only from meager personal knowledge. Instead, one should take the child out to show him real things instead of making "objects" that represent ideas and then closing them in cupboards. This was Montessori's theory.

Her technology of instruction had three major characteristics; adaptation of school work to the individuality of each learner; provision for freedom where the teacher did not dominate the learner, nor did the learner become overly dependent upon the teacher; and an emphasis on sensory discrimination. Montessori further emphasized the senses individually and in association with one another, working particularly with visual, muscular, tactile and auditory sensations. Through sight, sound and touch, she thought that children learned to distinguish shapes, sizes, weights, textures, colors and pitch. Thus, the Montessori method was a blend of three divergent elements; two fundamental tenets of learner individuality and freedom; and a specific technique for sensory training.

As with many of her predecessors, Montessori considered sense training to be a precondition of higher intellectual functioning. She stated that passage to the second level of education was passage from the sensorial, material level to the abstract. According to Montessori, the need for abstraction in intellectual activity becomes apparent around the seventh year, which is about the time when establishment of the relationships between objects becomes important to the child. She thought that at that time the child felt an inner need to classify and absorb the exterior world by the means of his/her senses, and turned to the intellectual and moral sides of life (Montessori, 1973).

Summary

Montessori had individualized the educational process once again, just as Kant and Pestalozzi had done a century before. And as their ideas were a natural outgrowth of Comenius and Rousseau, hers resulted from a dissatisfaction with the pedantic style of Dewey. But as each historical layer of sensory thinking was laid, mistakes were made ... and sometimes compounded.

For instance, though Comenius was farsighted in his belief that all knowledge began with experience, he improperly assumed that:

> From the evidence of sensation grows the degree of knowledge, whereas, if the sense perceives anything afar off or weakly or obscurely, it is a general conception. If nearer, distinctly and perspicuously, it is a

particular conception (Sadler, 1969).

He oversimplified what scientists today know is not at all a simple process. Locke's blank slate theory was no less an oversimplification, but Rousseau's and Pestalozzi's concentration on the child instead of the stimulus expanded the thinking of the day. With that foundation in thinking, the next logical step was wondering how students use what their senses told them. Herbart answered that query with his apperception theory. As Froebel and Dewey laid the last bricks of the foundation, Montessori built upon them.

But in spite of the laborious stone upon stone effort made to understand the learning process, educators today are still asking the same difficult question, "How do we learn?" However, educators are also asking, "Why is it that some people do not learn?"

Human Memory and Digit Span As They Relate To Learning

Perhaps one of the most valuable lessons gained from the history of sensory thought was that learning would not work in the same way for every student. Instead of the universal teaching method, what was needed was a better way to explore the mechanism that processes sensory information and turns it into knowledge. Today scientists have established that the memory takes over the process from the senses. Memory then holds information that the senses supply (Loftus and Loftus, 1976).

Early nineteenth century theorists, James Mill and John Stuart Mill, (Bigge and Hunt, 1968) proposed that there were two different kinds of memories. Many years later, experimental psychologists, Wilhelm M. Wunde, Ernst Meuman and American William James (Loftus and Loftus, 1976), confirmed that idea. According to these men, the human memory functions with a primary short-term memory and a secondary long-term memory. Though the existence of two kinds of memories was fairly well accepted, further research into their specific functions did not occur until the late 1950's with the discovery of computers. As computer science developed, human behaviorists began to recognize that words like data input, encoding, storage and retrieval seemed to describe the organic mind and inorganic computers equally as well. Even programming occured in both systems. With more sophisticated computers came models of behavior and mathematical psychology.

Human memory and information processing was compared to specific computer functions, and the analogy grew. Computer software was likened to the capability of the individual learning to add or ride a bicycle (Loftus and Loftus, 1976). The computer analogy proved to be a fruitful approach, and inspired fresh-thinking and new avenues of investigation into the shape of human memory.

Theories regarding the human memory flourished in the 1960's by a number of psychologists, including Waugh (1965) and Atkinson and Shiffrin (1968). It became accepted that memory consisted of: 1) a sensory store

which lost information in about one second; 2) a short-term store with a rehearsal buffer which lost information in about fifteen seconds; and 3) a long-term store (Loftus and Loftus, 1976).

Through experiments, Postman and Phillips (1965) and Glanzer and Cunita (1966) demonstrated the existence of short-term and long-term storage in human memory. Short-term memory capacity was investigated early through memory-span experiments (Hayes, 1952, and Pollack, 1953) and was shown to be able to hold about seven bits or "chunks", where a "chunk" is anything with a unitary representation in the long-term store (Miller, 1956). During the above work, investigators made extensive use of strings of digits, letters or variations of the information including the serial position curve; retroactive and proactive interference tasks; delay; and partial and complete reports to differentiate the short-term memory components and their functions.

Later refinements included identifying iconic and echoic components of the sensory store, based on experiments with the visual channel (Sperling, 1960) and auditory channel (Darwin, Turney, and Crowder, 1972). Sperling, Darwin, and other investigators found that decay of the information from these sensory store components occurred over a range of 200 to 1000 milliseconds for iconic and about four seconds for echoic.

Model Development

In 1967, Sperling developed a short-term store model later adapted

by Loftus and Loftus (1976). The adapted sensory model included iconic and echoic components, limited capacity short-term store, large capacity long-term store, rehearsal process with maintenance and elaboration activities, and a scanning process with both attention and recognition activities. This adapted model simultaneously incorporated attention pattern recognition, limited capacity, rehearsal, and auditory information storage.

Also, according to Sperling's model, information is gathered by the individual either through the eyes into an iconic sensory store, or through the ears into an echoic sensory store. Data in either store is processed by the scanner, determining which information to process, and by pattern recognition. Output of the scanner fills up the seven slots in the short-term store with one "chunk" of information per slot. Note that the actual information does not go into the slot but follows a pointer to the area of the long-term store where it is placed.

The next component is a rehearsal process (mind's voice) that goes successively through each slot creating an auditory representation of the information. This acts as new auditory stimulus and the information is placed in the echoic store. The scanner then reoperates on the echoic store, replacing information and providing a continuous recycling process for information in the short-term store (Loftus and Loftus, 1976).

Focus on Short-term Memory

According to Atkinson and Shiffrin (1971), the investigations of human memory have tended to focus on short-term memory only. This is because the processing done in the short-term memory is controllable, allowing the subject to regulate the flow of information in the memory system. These processes can be summoned up by choice and result in the ability to measure the effects of the subject's performance.

The control processes in short-term memory include rehearsal, coding, decisions, and retrieval strategies (Atkinson and Schiffrin, 1971). Rehearsal may be overt or covert (Gruenfelder, 1975, and Atkinson and Schiffrin, 1971). Coding may involve organizing material for storage (Billezza, 1978, and Hall and Madsen, 1978). Decisions may involve paying attention to certain sensory input selected for entry into short-term and long-term memory (Loftus and Loftus, 1978). Strategies may also involve selecting cues or mnemonic devices to facilitate retrieval from long-term memory (Annis and David, 1978, and Hall and Madsen, 1978). All of these processes are subject to individual control and may vary with different tasks or with the same task at different times.

A byproduct of the short-term store investigations may be a growing interest into a new phase of memory, that could provide some real hope of an answer into the query, "Why is it that some people do not learn?"

Since all internal processing begins with echoic and iconic

channels feeding data into the short-term store, it is logical that a malfunction here could radically affect learning. For instance, if one channel is weakened in supplying false information, or if a student has five or six functioning slots in the short-term store instead of the normal seven digit span capacity, failure to learn at the usual rate would appear to be nearly automatic. However, incoming information is only half of the problem. The other part of the problem is proper responses. Both a lessened digit span capacity or a weakened modality channel could mean that giving back the right response would be difficult.

In summary, why some people do not learn, may be due to malfunctions in the encoding systems and processing or playback systems. Furthermore, if a learning problem is not corrected regarding sensory processing, other attempts to remediate academic failures may either be short-lived or futile.

Inner Language

The problem regarding sensory processing is further complicated by a concept called inner language. Inner language is the transfer of information, whereby the brain assimilates data into meaningful individual terms, and then expresses this information in appropriate terms. Because of the nature of information, researchers describe both visual and auditory inner language. An example of visual inner language happens when someone is asked to spell a word. Normally, the word can be "seen" internally. Then that internal visual impression is transferred onto paper by

copying the image.

An example of auditory inner language happens when someone is asked to repeat a given telephone number. The digits are "heard" internally before they can be vocalized or written. Through recalling what was "heard", the number can be expressed either verbally or in written symbols. This is consistent with Sperling's description of the iconic and echoic stores.

Conflicting theories have arisen to explain inner language processing. Bannatyne (1973), talks about inner language in terms of understanding the meanings of spoken words. In a phonetic language, meanings are always associated with the spoken word, not the printed word. The printed word is then associated with the spoken word. Further, Bannatyne illustrated the function of language in this way:

meaning (concept or object)

spoken or heard word (auditory-vocal phonemes)

printed or written word (graphemes)

Consequently, in a phonetic language like ours, the visual symbols actually represent sounds, not meanings. They only have meaning when they are strung together in auditory-vocal words.

Bannatyne emphasizes a need to develop auditory inner language through vocabulary development for meaning. Basically, he feels that the

visual inner language is useless unless auditory inner language functions accurately first, so that meanings of the visual symbol are understood. According to Bannatyne, the printed word is a phonetic code for our auditory-vocal language. The inner language decoding/coding process uses many forms of psycholinguistic memory which act separately or together. Reading and writing should become automatic functions, freeing people to concentrate on auditory-vocal language, which is a vehicle for meanings. By training their psycholinguistic memory functions to reach an automatic level, students will progress more rapidly toward the truly creative purpose of language.

Eisenson (1963), another authority in speech and language, believes that inner language comes first through the visual channel. He states that the main objective should be for the child to establish visual perception skills. Through visual perceptual functioning the child should learn coping strategies for knowing what he is able to do in relationship to visual events. Eisenson believes the child acquires a form of inner language ... a way of "talking to himself" without words ... to relate and transform experiences into a set of basic visual symbols.

Eisenson views perception as the process of organizing events into categories. He feels that a category represents a group of experiences with common denominators. This classifying process is spontaneous in normal children, or an automatic process. In brain-damaged children, this ability is impaired, however, and teachers must assist the pupil in

learning to generalize and categorize.

Eisenson's sequential pattern of how inner language developes looks as follows:

level	operation
1	Object-to-object association.
	matching of identical objects
	matching of like-but-not-identical objects
2	Categorical matching.
	matching of identical objects to pictures
	matching of similar objects
	matching of similar pictures
3	Matching by associated function.
	associated object grouping
	associated picture grouping
4	Object categories - sequencing.
5	Picture categories - sequencing.
6	Which one is different (objects and pictures)?

His basic philosophy is that the establishment of a representational system and inner language as bases for symbol behavior should not be delayed. Ultimately, he believes that symbol behavior will progress to a higher level as a child is trained to his strengths. By training through a sequential visual perception program, Eisenson hoped to overcome weaknesses in auditory perceptual functioning, and allow the child

to make sense out of sound.

While Bannatyne and Eisenson agree that the initial step towards inner language functioning involves meaning, Eisenson's method takes the child through the sequential states of concrete to abstract by using the visual channel. Bannatyne's approach is based on an auditory system.

Since ultimately inner language development must involve both visual and auditory channels, perhaps a combination of these two theories provides a more complete picture.

Modality Preference

Bannatyne and Eisenson's point of view form a comprehensive system of perceiving strengths and weaknesses as they relate to modality capabilities. This idea has led to the notion of auditory learners, visual learners, and learners needing haptic and kinesthetic feedback.

The idea of modality preference was the subject of an analytical literature review done by Tarver and Dawson (1978). They examined fourteen studies about the interaction between modality preference and methods of teaching reading. Twelve of the studies indicated no interaction between modality preference and methods of teaching reading. The research concluded that modality preference and methods of teaching reading are not aptitude-treatment variables that can be effectively matched. In other words, the modality strength-deficit question appeared to not be a

crucial part of establishing methods of teaching reading.

Tarver and Dawson reviewed these fourteen studies looking for three basic pieces of information. Does evidence show a link:

(a) between modality preference and how reading is taught?

(b) between modality preference and reading achievement, no matter which teaching method is used?

(c) between teaching method and reading achievement regardless of modality preference?

Investigators of these questions found some built-in problems that at times hampered or perhaps even altered their final data. The most fundamental difficulty lay in an accurate diagnosis of modality preference. However, once that could be accomplished, there was still the difficulty of deciding whether the strength or deficit-oriented treatment was best; or perhaps whether one learning style was superior to another regardless of preference.

Cronbach touched upon the importance of this issue in his 1957 APA Presidential address.

> "For any practical problem, there is some best group of treatments to use and some best allocation of persons to treatments."

The researchers agreed on the basic theory, but there was a wide variance in opinion about the most likely starting point.

For instance, Mills (1955) concluded that for teaching word-recognition skills to a seven year old, the visual method was best. The Goins study (1958) and Bryan study (1964) support his view and expand it to add that visual-perceptual skills are linked significantly to beginning reading achievement.

Bateman (1967) on the other hand, had decided that not only was auditory-type instruction superior as a way to teach reading and spelling, but those students classified as having an auditory preference performed better in those areas.

However, in a large body of studies from Nila (1953) to Murdock and Walker (1969) all concentrating on learning style, the results appear so contradictory that little use can be made of them. Gagne (1967), in fact, tends to negate the whole question of a superior learning style.

> "... differences (between learning approaches) are so evidently and heartily wished for that one almost believes they exist. Yet the fact of the matter seems to be that almost none are verified realities."

While Gagne is not ready to abandon the idea of learning style influence, he suggests that much more research is needed.

In contrast, the Wepman (1967) and the Sabatino and Hayden (1970) studies both hypothesized that the strength-oriented aptitude treatment approach was best. Wepman recommended upgrading the deficit modality so

that the two could later be used jointly. Sabatino and Hayden rationalized that the strength-oriented approach helped to reinforce a positive attitude about learning.

Lining up on the opposite side of this issue were the Hallahan and Cruickshank (1973) and the Wallace and Kauffman (1973) studies. Hallahan and Cruickshank believed that in order for the student to learn all manner of tasks ... some auditory in nature and some visual in nature ... a deficit oriented approach had to be followed to bring the student's ability up to a normal level. Wallace and Kauffman describe the deficit as a sort of feedback problem that can be overcome with proper teaching emphasis.

The Kirk and Kirk study (1971) strikes a balance between these two opinions, and proposes that instead of a strength or deficit question, the real treatment ought to deal with the inner language blending of all three modalities necessary for learning.

However, both the Kirk and Kirk study, and the earlier Johnson and Mykleburst study (1967) warned that bombardment by too many different kinds of sensory stimulation could overload the student's nervous system.

However, since proposing a treatment direction is just the first step, a properly controlled set of data plugged into a properly designed set of research criteria must be the investigator's next concern. Cronbach and Snow (1969), and Ysseldyke (1973) suggest that in order to

provide valid support for any leg of this matching process, the design must include at least two modality preference groups fully crossed with two treatment groups.

When Tarver and Dawson reviewed the population data these studies were based on, discrepancies were even more notable. There was too wide a range of students' ages and there was no factoring of intelligence. In addition, proper controls of the learning set were missing.

The two studies that did report significant interaction between modality preference and the method of teaching reading also showed deficiencies in procedures and direction (Bursuh, 1971, and Lilly and Kelleher, 1973). The first investigation (Lilly and Kelleher, 1973) could better be described as research on the relative effects of reading and listening on recall. In the second study (Bursuh, 1971), the effects of a listening approach to reading were compared to an approach involving only reading. The results were seen as support for a strength-oriented approach because the combination method results in better performance for auditory and non-preference learners. While the visual method results in better performance for visual learners.

The results of these two studies could indicate that modality preference may interact with how material is presented in relation to recall. However, the conclusion that reading should be taught through the strong modality would not appear to be valid, since it was based on

an unproved assumption, that reading and listening were related.

Tarver and Dawson's analytical review also looked at what the studies said about the effect the modality preference and teaching methods had on learning to read. They found that: 1) nine of the fourteen studies showed no effects with modality preference; 2) ten studies showed no effects with teaching method; 3) two studies showed an effect of teaching method; 4) one study showed partial effects of modality preference and teaching method; and 5) two studies did not provide information on the effects.

Although these last findings may show some indication of an interaction between modality preference and methods of teaching reading, the greatest weight of the experimental results does suggest that modality preference and teaching methods have no effect on learning to read. (Gagne, 1967). Taken as a whole, the body of research lacks the consistency to draw useful implications for classroom practice.

Another group of educators viewed modality preference a bit differently. They believed that stressing auditory perception skills was not only the correct method, but an essential one because certain auditory skills were prerequisites for mastering reading. Conversely, a deficiency in any of these skills meant that reading failure was nearly assured. These thirty-three studies, analyzed and reviewed by Hammill and Larsen (1974), were conducted over a period of thirty-four years, beginning with

Rizzo's study in 1939, and ending with Barnsley et al, in 1973.

In general, all thirty-three studies investigated the relationship of reading measurement to measures of phonemic and non-phonemic auditory discrimination, memory, blending and auditory-visual integration. The hope of these assorted researchers was that if a reading deficiency could statistically be linked with auditory skill deficiencies, then testing to find those auditory deficiencies early in a student's career could serve as an indicator of reading problems to come (Hammill and Larsen, 1974).

Hammill and Larsen approached this body of research seeking to answer these four questions:

1. Is there a significant relationship between certain auditory perception skills and general reading ability?
2. Is there a significant relationship of certain auditory perception skills to reading ability at different grade intervals?
3. Is there a significant relationship of certain auditory perception skills to certain reading subskills?
4. Is there a correlation between auditory skill test results and reading ability?

For their part, Hammill and Larsen chose to compare results of the studies using a .35 coefficient as the lowest value of significance.

As in the cases reviewed by Tarver and Dawson, research was found to contain inherent unmeasured variables that may have biased the results. First, most researchers (66%) had designed their own auditory perception measuring instruments. Consequently, testing devices were not always proven to be valid. Second, only seven studies factored out the subject's mental abilities. And third, only four of the studies were long-term enough to determine if the results held up over a period of time (Hammill and Larsen, 1974).

On closer investigation of how specific auditory skills related to general reading ability, Hammill and Larsen found that,

> "... the median coefficient between reading and the combined auditory skills was not significant ..."

Individually, auditory-visual integration, memory and nonphonemic discrimination showed measurements of insignificant value, while sound blending and phonemic sound discrimination were valued at .24 and .26, but still measured too low to be useful.

Of the seven studies that considered mental abilities a variable factor, only one study showed a significant relationship. The Kahn and Birch (1968) evidence indicated that a relationship existed between auditory-visual integration and general reading ability. However, the Bruininks (1969), Ford (1967), and Vande Voort and Senf (1973) studies matching the same evidential criteria, did not validate that

relationship.

Next, the reviewers looked at the data to find whether separating studies into grade levels would change the values. Groupings consisted of students at grades 1-3, 4-6 and 7-12. The auditory-visual integration variable was eliminated in the secondary level, however, because of lack of evidence to support a correlation. Results again showed no significant levels of relationship, although the correlation measured highest at the elementary level at .24.

When the same body of evidence was broken down even further to compare specific skills to grade level reading abilities, only sound blending matched at the secondary level to reveal a workable relationship of .35. Overall, auditory skills were not more highly related to a reading subskill (Hammill and Larsen, 1974).

The reviewers moved on to the next question: Will particular auditory skills show a relationship to a particular reading subskill? Again, the evidence included only one study that showed a significant value between two of the variables. This time, the relationship between auditory-visual integration and reading comprehension measured .37. Hammill and Larsen (1974) drew the general conclusion, however, that auditory skills were not more significantly related to reading subskills than to reading in general.

The final consideration was whether or not there might be a specific relationship of auditory tests to general reading ability, thereby allowing test results to serve as predictors of reading mastery. As was previously mentioned, most researchers designed their own testing instruments. However, certain standard tests were used frequently enough so that results of those tests could be examined for relevant data.

Of all the tests administered, one showed promise. The Roswell-Chall Auditory Blending Test disclosed a high correlation value between reading ability and test results. But, since the evidence that produced this .47 factor was taken from the Chall et. al. study, these results appear open to question. When other researchers, McNish (1971) and Bruininks (1969) applied this same test to their evidence, the resulting values were much lower, .33 and .31 respectively. In addition, only the Bruininks study had partialed out mental ability.

But Hammill and Larsen also wished to see if any of the auditory skill tests might prove to be predictive if the reading ability of each student was correlated over a long time period. Four of the thirty-three studies were long-term enough to suit their purposes: De Hirsh et. al. (1966), Hirshoren (1969), Chall et. al. (1963), and Bagford (1968). All of these studies compared auditory test skills scores to reading achievement after a minimum of two years, and Bagford's research expanded that time frame to measure first grade auditory results against sixth grade reading achievement levels.

The results were mixed. Bagford reported that speech sound discrimination tests served as a useful predictor; Hirshorn correlated an auditory memory test with two reading subtests; and Chall reported encouraging results in matching sound blending and reading achievement in the third grade. De Hirsh found that none of the coefficients exceeded .30. Of the four studies, however, only Chall et. al. considered the influence of the student's mental ability.

The factor of a student's mental ability appears imperative to be considered in research that explores the differences between auditory skill levels in good and poor readers. Hammill and Larsen (1974) suggest that separating students into good and poor groupings also tends to separate them intellectually. Therefore, research separating good and poor readers should also consider mental ability a variable. Consequently, research that does not incorporate this provision into the design of the study would appear to result in questionable findings.

In addition to the mental ability variable, it may be that other learner variables are also a part of the learning to read process. For example, learning disabled children show differences from their normal peers in attention abilities: impulsivity-reflectivity, and field dependence (Hallahan, 1975). Rate of learning is another learning variable of consequence. Research by Camp (1973) indicates that disabled readers exhibit quantitative differences rather than qualitative differences, and that perceptual functioning and learning rates are not related. The

latter finding questions the existence of a meaningful relationship between perceptual deficits and learning rates. If this is valid, reinforcement and repetition that have successfully increased learning rate in normal children may be just as useful in helping disabled learners.

Tarver and Dawson recommend that focus should be placed on exploring task requirements at various stages of learning to read. This could lead to a validated sequence of reading skills. These skills, combined with assessment of the child's learning rate, may promote a successful individualized reading program. The individualized program may be based on quantitative differences in progression rates through a specific sequence of reading skills, rather than on a qualitative difference in perceptual functioning. To confirm the findings of Tarver and Dawson, Arter and Jenkins (1977) reviewed fourteen other studies assessing the modality/instruction interaction model. All but one of these studies showed no benefit in learning from teaching to the modality strength of the child.

Hammill and Larsen (1974) also rejected the notion that the process of learning to read must be based on certain auditory skills. They identify as a priority the development and examination of standardized instruments to study basic research questions of how training auditory perception and cognition affects both the skills themselves and reading ability.

One of the test commonly used for studies over a twenty year

period was the Mills Learning Methods Test. Lilly and Kelleher (1973) report that it requires cautious interpretation, and has questionable reliability. Another perceptual instrument, the Illinois Test of Psycholinguistic Abilities (ITPA), also seldom yields precise visual and auditory distinctions across subtests in individual children. The Illinois Test of Psycholinguistic Abilities also is difficult to administer and has questionable reliability according to many reports (Paraskevopolous and Kirk, 1969).

In an effort to develop a memory test that did relate to the reading process, Lilly and Kelleher (1973) decided to measure memory for words. They developed a Visual Memory and Auditory Memory Test using words in the immediate sight vocabulary of children. The test included short stories of seven to eight sentences in length. Their studies on this instrument hoped to establish the modality preference using more reliable memory subtests and tightening experimental procedures (Lilly and Kelleher, 1973). The results of their study showed promise in establishing the relationship between auditory and visual memory without learning.

There could be several explanations to account for the consistent failure of research to support the modality/instruction interaction matching model: 1) The model itself may be invalid - modality strength may be a non-functional factor in instruction. 2) Even though the model may be accurate, other stronger and uncontrolled factors may conceal the effects of modality preference. 3) Instructional procedures that are modality pure may not be employed in the curriculum. 4) It may be that instruments

have not been developed that can accurately measure modality strengths. K. Stephen Lilly and John Kelleher (1973) maintain that early attempts at diagnosing modality preference proved inconclusive due to diagnostic measures. Reading, for example, seems to require both auditory and visual skills, suggesting that it may be impossible to develop instructional methods emphasizing a single modality. Treatment procedures that are labeled visual and auditory are different in many more ways than just the modality dimension. For example, in Bateman's (1967) study, a phonetic approach and a whole-word approach were labeled auditory and visual respectively. Therefore, materials were assigned opposing characteristics on the basis of different variables.

However, researchers may find that testing modality strengths alone is a bit like treating the symptom and ignoring the cause of the ailment. Perhaps, instead of asking which channel is stronger or weaker, educators may wish to focus either on the relative strength of each channel, or on a deficit that may affect performance. Testing modality channels may not supply the complete answer.

Testing Digit Span

There is a possibility that even when accurate modality tests are devised, the information they give indicating a strength or weakness may not solve the problem in the future. If one channel is weak, but necessary in order to learn a skill, such as reading, then one beneficial answer would be to find the source of the deficit and strengthen the channel.

Testing digit span capacity to analyze what happens beyond the modality channel in the short-term memory store may be exactly what is needed.

To properly diagnose a child's ability to see, hear, process and remember data correctly, diagnostic tests that assess memory processing from two types of stimuli appear absolutely critical. Five tests are reviewed here which have been developed to identify visual and auditory deficits in this manner including the Wechnsler Intelligence Scale for Children - Revised, the Visual Aural Digit Span Test, the Receptive-Expressive Observation, the Illinois Test of Psycholinguistic Ability and the Detroit Test of Learning Aptitude. However, it appears important to identify the limitations present for each test.

The Wechsler Intelligence Scale for Children - Revised (WISC-R) includes one subtest to diagnose digit span (Wechsler, 1974). This subtest requires that the child; a.) attend, b.) concentrate on auditory stimuli, and c.) repeat the digit sequence heard. An average or above average score on this subtest indicates that the student has good ability to concentrate on oral presentation. Scores, however, are not an indication of ability for long-term memory. Banas and Wills, (1978) note that discrepancies in test scores occur because students who score high in this digit span subtest can increase their attention, intake accuracy and immediate recall by verbalizing quietly to themselves as they work. This can make their scores higher than their actual ability, and appear consistent with the discussion earlier on inner-language and the echoic

store.

The Visual Aural Digit Span Test (VADS) is administered individually to each child and consists of four subtests: 1) Aural-Oral, an aural presentation of a digit series then oral recall. 2) Visual-Oral, a visual presentation of digit series and then oral recall. 3) Aural-Written, an oral presentation of digit series than written recall. 4) Visual-Written, a visual presentation of digit series then written reall. The longest series of digits that a child reproduces correctly from memory becomes the subtest score. No more than seven digits are presented at a time, so seven is the highest possible subtest score. The highest possible total score is twenty-eight (Koppitz, 1973).

The VADS test specifically relates to reading and identifies children's visual-aural integration, sequencing and recall. Elizabeth M. Koppitz Ph.D. conducted a study of correlation between the VADS test, the Bender Gestalt Test, and reading performance of three groups of eight and nine year old children. Two groups of pupils with learning disabilities were tested. One of the groups could read, and two of the groups could not read. Study results indicated a significant difference between the VADS total scores for special class pupils who could read and those who could not read. Since the Visual-Aural subtest involves the same visual perception of printed symbols and the aural recall of what has been perceived as reading does, it was most closely associated to reading achievement. Further analysis of the study suggests that an eight or nine year

old child with good visual perception and good aural recall can learn to read, even when visual-motor integration is immature due to problems in visual-motor coordination. A child's reading ability is most seriously impeded, however, if the student has poor auditory recall and poor visual recall for sounds and symbols (Koppitz, 1971 and 1973).

The Receptive-Expressive Observation (REO) includes four subtests: Visual-Vocal, Visual-Motor, Auditory-Vocal and Auditory-Motor. The procedures for the subtests are as follows:

1. Visual-Vocal Subtest. The examiner presents a stimulus card for a five second observation period and removes it. Then the subject is asked to repeat what was seen. The digit sequence begins with two items and continues through six items, or until the subject misses two trials on two consecutive items of one subtest (Smith, 1973).

2. Visual-Motor Subtest. The subject is shown the card for five seconds, and is then instructed to write what was seen.

3. Auditory-Vocal Subtest. The examiner vocally presents items and then instructs students to repeat what was said.

4. Auditory-Motor Subtest. The student is provided with a sheet of paper, is asked to listen to the examiner and then write down what was heard.

The REO is a standardized instrument. Studies with the Wide Range Achievement Test and the Peabody Individual Achievement Test with the REO found significant correlations in academic areas (Smith, 1973).

The Illinois Test of Psycholinguistic Ability (ITPA) includes twelve subtests designed to measure communication channels, organizational levels and processes of psycholinguistics (Tarczan, 1975). The battery of tests requires approximately two hours to administer, to an individual pupil, and by an experienced and qualified examiner. It is intended for use with children from two and one-half years of age through nine years of age. The memory capacity of a pupil is assessed in two of the subtests; Visual Sequential Memory and Auditory Sequential Memory. These two subtests examine automatic language habits. The remaining subtests assess decoding, expression, encoding and association skill development. The ITPA was standardized in 1950 with representation from the social classes at that time. However, the author did not consider racial population in the sample (Tarczan, 1975).

The Detroit Test of Learning Aptitute (DTLA) was developed in 1967 to assess learning capability of individuals three years of age through adult. The DTLA includes nineteen total subtests, with generally nine to thirteen of the subtests being administered to an individual to ascertain a learning profile. Eight psychological functions are examined including comprehension and reasoning, practical judgment, auditory and visual attentive ability, verbal ability, time and space relationships, number ability and motor ability. The attention span subtests specifically measure digit span abilities of an individual from visually and auditorily presented stimuli. As described for the ITPA, the DTLA must be individually administered by a well qualified examiner and takes a lengthy

period of time to administer.

A comparison of the Wechsler Intelligence Scale for Children - Revised, the Visual Aural Digit Span Test, the Receptive-Expressive Observation, the Illinois Test of Psycholinguistic Ability and the Detroit Test of Learning Aptitude, shows a progression of sensory testing instrumentation. While the Digit Span Subtest of the Wechsler tests only the auditory-oral channel of the memory process, the VADS measures all four channels of communication. However, the VADS test includes only numbers as stimuli. The Receptive-Expressive Observation also tests all four channels and uses different types of stimuli in each channel. The ITPA tests the visual motor and auditory vocal channels for pupils from two and one-half through nine years of age. The Detroit Test of Learning Aptitude again does not assess all four channels of processing, nor does it encompass the various forms of information generally encountered in a learning environment. However, all five tests described require an individual administration, taking significant staff and pupil time for testing. A lack of personnel, time and funds would appear to inhibit the use of testing to measure for sensory deficits. Logically, there appeared to be a need for a group screening process that could be given to an entire class to identify digit span memory deficits and diagnose the broad spectrum of students at an early age.

Rationale for the Learning Predictor

The Learning Predictor was developed to solve this administration

problem and is an extension of the Receptive-Expressive Observation. Basically, the Learning Predictor utilizes the Receptive-Expressive Observation's motor subtests. The visual-motor section includes a series of digits - including numbers, letters, shapes and words. The visual information is presented by the examiner on a transparency by projecting an image on a screen, removing it, and asking the students to write the digits in sequence on a piece of paper. The Receptive-Expressive Observation has a maximum of six digits. The Learning Predictor expands this to eight digits, which is considered appropriate at the twelfth grade level. The Auditory-Motor subtest requires that the students listen to data and then reproduce the information presented in writing.

After initial identification of the sensory deficit through the utilization of the Learning Predictor, a pupil may then be tested to obtain more diagnostic information with the administration of the five instruments described earlier. Administration of individual instruments will provide more indepth information on the ability of the student to receive and recall information in the four channels utilized in the learning environment rather than only assessing the two channels included within the Learning Predictor.

Teacher Ratings of Reading Achievement

Part of the research study included a rating of each student's reading achievement level by the classroom teacher. Each classroom teacher

was asked to assign students a ranking of: 1) reading below grade level; 2) reading on grade level; and 3) reading above grade level. In answer to questions regarding the credibility of teacher evaluation, past research indicates that in the majority of cases, teacher assessments are both fair to students and measurably accurate.

In 1947 Kottmeyer undertook a significant study that investigated the teacher's ability to subjectively predict first grade reading success. Results showed that teachers' subjective judgments were as valid as results obtained by formal testing. Teachers with more than ten years experience predicted reading success with even greater accuracy than those with less experience. A study by Kermoian (1962) indicated that the classroom teacher's appraisal of pupil readiness for first grade work correlates significantly with that of a formal instrument (e.g. The Metropolitan Readiness Tests). This was true for each area of readiness evaluated - reading readiness, number readiness, and total readiness, determined on a five point scale, Superior, High Normal, Average, Low Normal and Poor Risk. It is interesting to note that teachers' subjective estimates are identical to M.R.T. ratings in over one-half of the estimates made and within one rank $\pm$ of the test scores of the remaining cases.

In a later study (Thomas and Chisom, 1973), teacher ratings were investigated to provide an alternative to objective testing for early elementary school children. The teacher rating scale was based on four

areas of academic achievement: 1) reading achievement; 2) quantitative achievement; 3) verbal achievement; and 4) listening achievement. Test instruments used were the Otis-Lennon Mental Ability Test (MAT) Primary I Level for the primer-group, and the Otis-Lennon Mental Ability Test, Elementary I Level for the first, second and third grade groups. Results showed a significant correlation between teacher ratings and the objective tests. The results lend support to previous studies reporting that teachers effectively assess the performance of children in early grades.

More recently, a study (Oliver and Arnold, 1978) compared the standardized test results, informal reading inventory placement levels, and teachers' judgments about where third grade children should be placed in reading instruction materials. The objective tests were the Iowa Test of Basic Skills and the Goudy Informal Reading Inventory. Without knowing the scores ahead of time, teachers were asked to judge instructional reading level of each student tested in their classroom. The highest correlation was found between teacher judgment levels and the informal reading inventory levels. On the average, the teachers placed the students one full reader level higher than the inventory scores. The next highest correlation, similar to that noted by Kottmeyer (1947), Kermoian (1962), and Thomas and Chisom (1973), was found between the standardized tests and teacher judgments. The lowest correlation was between the inventory and standardized tests. These study results confirm that teacher ratings closely parallel standardized test results.

However, an investigation using eleventh grade students as

subjects, conducted by Littrell (1968), found low correlations between subjective teacher ratings and measured reading ability. Unlike others, these study results indicated that teacher ratings for older students were ineffective.

Littrell's findings led to the review of another study consisting of eighth grade children. The investigation by Gomes, Bastos, Scheefer, and Michael (1977) was aimed at determining the extent teachers were able to detect levels of differential aptitudes in students through guided observation. The teacher observations were guided by the Teacher's Assessment of Students' Aptitudes, an experimental instrument to aid teacher assessments. The instrument included eleven areas with a brief description of what characteristics to observe in each area and a rating scale was provided to record teacher assessments. The criteria for validity of the guided observations was the Battery of Tests of Differential Aptitudes, which taps into the same aptitudes as the Teacher's Assessment of Students' Aptitudes.

After administration of both instruments, results indicated that using the Teacher's Assessment of Students' Aptitudes instrument enabled teachers to assess students' differential aptitudes with reasonable accuracy (rated with the results from the Battery of Tests of Differential Aptitudes). This suggests then that teachers are generally able to assess their students' aptitudes with the use of a guided observation instrument.

Summary

Studies do indicate that teachers' judgment is at least as accurate as standardized reading test scores, and perhaps more accurate depending on the teacher's training and experience.

Summary

Human memory has been the subject of intense investigation, analysis and experimentation for the last twenty years. Some of these investigations have led to the development of a model showing the components and operations involved in short-term memory. Other studies have investigated whether or not modality preference affects the learning process. The bulk of results indicates that teaching directed towards an individual's modality preference, does not seem to affect learning to read. Despite these data, the majority of special educators still believe in the effective use of a modality/instruction interaction model. However, the practice of altering instruction to accommodate modality strengths does not appear to benefit the learner, and in fact may be of questionable validity.

Perhaps looking beneath the surface problem will yield some answers to the puzzle of learning difficulties. Investigations into digit span capacity are reputedly doing exactly that.

Some better testing devices are already aimed at diagnosing

these deficiencies on a one-to-one basis. However, in each case (the WISC-R, VADS and REO), practical considerations of time and money often get in the way of a solution. The Learning Predictor, on the other hand, can be given to an entire class at once.

Studies on teacher ratings of elementary aptitudes show that teacher judgment is as accurate as standardized test scores and may even be more accurate as their training and experience increases.

While remediation of learning difficulties has been accomplished in many cases, evidence is mounting to indicate that current methods of remedial teaching and diagnosis are not working well enough. Responsible educators then have to ask, is there another way?

CHAPTER III

DESCRIPTION OF THE DESIGN AND PROCEDURES OF THE STUDY

Chapter III is divided into five major sections to detail the procedures used in the study. They are as follows:

1. The research design;
2. A description of the sample population;
3. A description of the data collection methods;
4. Descriptive information regarding the Learning Predictor; and
5. Statistical procedures used for the treatment of the data.

Research Design

The primary relationship which was important to this study was the relationship of pupils' scores on the Learning Predictor to reading achievement. Two major comparisons were included in the study: 1) the relationship between auditory perceptual recall and reading achievement, and 2) the relationship between visual perceptual recall and reading achievement. Other factors that related to the major comparisons included primary grade levels versus intermediate grade levels, Anglo-American ethnic background versus Spanish/Mexican, Black, or Asian ethnic background and male versus female.

Auditory Perceptual Recall and Reading Achievement

The scores from the Auditory Motor subtest of the Learning

Predictor were compared to the reading achievement levels reported by the classroom teacher. The Learning Predictor instrument has a T-score norm of fifty with a standard deviation of ten points (Smith, 1979). The classroom teachers reported reading achievement for each pupil in relation to above, on, or below grade level. The elementary pupil norms on the Learning Predictor Auditory-Motor subtest were then compared with the reading achievement levels reported for a determination of differences.

Visual Perceptual Recall and Reading Achievement

The scores from the Visual-Motor subtest of the Learning Predictor were compared to the reading achievement levels reported by the classroom teachers. As described earlier, the pupils' reported reading achievement levels were compared with the normed scores on the Learning Predictor Visual-Motor subtest to determine the differences.

Other Factors

Grade level, ethnicity, and sex data were collected on each elementary grade level pupil included within the population. These factors were then included in the study to determine if further differences were noted with their introduction. The major comparisons noted above were utilized with each factor individually to assess their significance in the relationship.

Sample Population

Two elementary schools in the Rio Linda Union School District

and one elementary school in the San Juan Unified School District were utilized to obtain a sample of elementary grade pupils. Pupils at the Sierra Elementary School and Hillsdale Elementary School within the Rio Linda Elementary School District were assessed on the Learning Predictor and data collected for grades one through six. In addition, the Schweitzer Elementary School within the San Juan Unified School District was utilized. Two classes at each grade level, in each of the three schools were included in the sample population. This totaled six classes at every grade level. Within each class, pupils were assessed on the Learning Predictor and teachers were interviewed regarding each pupils' reading achievement and the other data necessary to complete the study. The following data are summarized in table form to reflect the number of pupils at the primary and intermediate grade levels by each level of reading achievement:

Table 1

SUMMARY OF NUMBER AND PERCENTAGE OF PUPILS FOR THE PRIMARY AND INTERMEDIATE GRADE LEVEL WITHIN EACH READING ACHIEVEMENT LEVEL

	Reading Achievement Levels			
	Below	On	Above	Total
Grades 1-3	107 26%	178 43%	131 31%	416
Grades 4-6	139 23%	238 40%	218 37%	595
Total Pupils	246	416	349	1011

The Rio Linda Union Elementary School District is located in the northern portion of Sacramento County and has a population of approximately 7200 pupils. Nineteen elementary schools are operated within the District, and all include kindergarten through sixth grade levels. The District includes middle and low middle income populations, and the socio-economic composition of the area varies widely. Rio Linda residents represent a cross section of the world ethnic groups. Ethnic percentages within the district and the San Juan Unified School District breakdown as reflected by the data from the following table:

Table 2

SUMMARY OF THE ETHNIC REPRESENTATION BY PERCENTAGE WITHIN THE RIO LINDA UNION ELEMENTARY SCHOOL DISTRICT AND THE SAN JUAN UNIFIED SCHOOL DISTRICT

	Ethnic Groups Represented			
	Anglo-American	Black	Asian	Spanish/Mexican
Rio Linda Union Elementary School District	79.7%	8.6%	3.3%	6.2%
San Juan Unified School District	89.1%	1.6%	2.5%	4.6%

The San Juan Unified School District is also located in Sacramento County, in the northeast section. There are sixty regular education elementary schools within the San Juan District. The District is reported as one

of the twenty largest districts within California with a pupil population of approximately 50,000. The district is primarily comprised of a middle income population. However, a large compensatory education population has been identified within the target zones that meet requirements for Federal poverty funds (Compensatory Education Application, 1979). Though not to the degree noted within the Rio Linda School District, the San Juan Unified School District also has a wide representation of ethnic groups within its boundaries as reflected by the population distribution information from Table 2.

Data Collection Methods

Information gathered on each pupil included three primary types: 1) Assessment on the Learning Predictor; 2) Determination of reading achievement; and 3) Identification data regarding other factors, i.e., sex, grade, etc. The following description details procedures used for each type of information collected.

Administration of Instrument

Four clinicians were employed to administer the Learning Predictor. The clinicians were trained in administration techniques on the testing instrument by the researcher. Each clinician also had previous teaching experience. The Learning Predictor was administered to pupils in each of the thirty-six classrooms included in the sample during April 1978. The instrument was administered in the classroom by two clinicians, with one

presenting the visual and auditory information from the Learning Predictor while the other clinician moved about the classroom. In addition, the classroom teacher was present during administration of the test. Presence of the second clinician and the classroom teacher was necessary to insure that pupils completed the test correctly. The two clinicians and the classroom teacher also helped to eliminate pupils copying the items instead of using the memory component. The Learning Predictor was administered during the morning session at each school.

Written permission was obtained from the two participating districts to administer the Learning Predictor to individuals within the sample school environment. Consent was obtained before the clinicians were scheduled. In addition, members from the testing staff met with each school staff in the sample to describe the procedures, information needed, and the timeline for completing the study. This facilitated communication so that when the clinicians arrived on the scheduled day, the school staff was prepared for the event.

Following administration of the instrument in each classroom, the protocols were collected. The pupil protocols were later scored by the clinicians and prepared for computer processing. See Appendix A for the score sheet code information, Appendix B for key punch instructions, and Appendix C for the data collection form.

Reading Achievement

The teacher of each classroom included in the study was asked to

report reading achievement for each pupil in his/her classroom. One clinician interviewed the teacher to record the reading achievement level reported on each pupil. The levels of reading achievement described were either above, on, or below grade level for each pupil. Teachers were asked to consider overall reading achievement in making the determination. Grades received by the pupil, the specific reading book the pupil was currently in, and the reading group which the pupil participated in, were factors which were suggested that the teacher consider in determining the reading achievement level. (Refer to Chapter II for a discussion of the validity of utilization of this methodology.)

Identification Information

Code sheets were prepared to record all identifying information relating to each pupil. Data relating to grade level, ethnicity, bilingual status, sex, school name, as well as reading achievement, were then recorded on the code sheet for each pupil by a clinician. Each pupil in the classroom was assigned a code number. The identifying data for each pupil was matched with the code number and the names did not appear on information leaving the school. The code numbers were also used on the test protocols to further assure confidentiality. See Appendix C for the data collection form.

Description of the Learning Predictor

The Learning Predictor is an instrument which was developed to

assess visual and auditory motor perceptual ability. The input modalities of visual and auditory stimuli are used with a fine motor response. Digit recall of each pupil is assessed for one to eight digits. Numbers, letters, and shapes are employed as both visual and auditory stimuli to provide varied input modality items. Visual items are presented to the pupil for five seconds, removed, and the pupil asked to record what he/she saw. Auditory items are dictated verbally to the pupil. Following the entire sequence, the pupil is asked to record what he/she heard. A total of forty-eight items is administered to each pupil with eight items for the three types of symbols in both visual and auditory input channels.

The Learning Predictor was developed on the base established by the Receptive-Expressive Observation. Two of the subtests of the Receptive-Expressive Observation were employed in the group sensory instrument in a manner similar to that of the Learning Predictor. In the Receptive-Expressive Observation, the Visual-Motor subtest requires the student to observe data visually and to reproduce the data in writing. The Auditory-Motor subtest requires the student to listen to data and to reproduce the data in writing.

Stimuli for the tasks are common to school settings; they are numerals, letters, and shapes. For tasks involving numerals, the digits from one to nine were combined into sets of one to eight numbers in length. None of the sets had runs of continuously increasing or decreasing values, such as 1, 2, 3, or 3, 2, 1, beyond two positions. The

digits can be considered a random sampling of all possible permutations of digits from one through nine. Stimuli employing letters of the alphabet can be considered a random sampling of all permutations of letter combinations. Four familiar shapes were employed; X, circle, square, and triangle. Sets consisted of one to eight shapes. One try is allowed on each trial, with all children completing the entire instrument. Appendix D contains copies of the test items and Appendix E contains protocol forms.

Reliability of the Learning Predictor

Reliability of a test refers to the dependability and stability of the instrument. Reliability is a generic term which refers to several types of evidence which demonstrates the degree to which the measurement is free from random influence and the degree to which similar results of a measurement will be repeated.

The reliability of the Learning Predictor was tested on a scalogram scale to determine how closely the results of the Learning Predictor correlated with the following properties: 1) The items of the Learning Predictor increased in difficulty in an orderly manner. 2) When a subject misses one item, all items of increasing difficulty are also missed (Smith, 1981). A coefficient of reproductibility was obtained to measure the correlation of the Learning Predictor to the properties described. An examination of the coefficients for the subtests of the Learning Predictor yields .87 and .90, which indicates reliability of a scalogram

(Smith, 1981).

The Learning Predictor was also examined for a coefficient of scalability, to determine if the scales were undimensional. A value above .60 is usually indicative of an undimensioned scale. The coefficients of scalability for the Learning Predictor ranged from a low of .41 to a high of .75. The Learning Predictor Manual explains this range of coefficients as follows: "This may appear low at first glance, but a closer look indicates that the low coefficients appear for numbers and letters while coefficients for shapes are well above the .60 level. If one considers the large sample and the range of education levels, it is not surprising that memory for numbers and letters may be tapping into more than one dimension while memory for shapes is more likely to be consistent across all grades and therefore, be a better measurement of the one dimension" (Smith, 1981).

In addition to the above discussion, the results of the Pearson Correlations from the step-wise multiple regression analysis presented in Chapter IV lends evidence of the reliability of the Learning Predictor. A correlation of $r = .61$ was established between elementary school pupils' performance on the Auditory-Motor subtest and the Visual-Motor subtest of the Learning Predictor. A measure must be characterized by reliability (self-correlation) to have the potential of correlation with another variable. The specific equation which describes this relationship is that the maximum correlation between two variables is the

square root of the product of their reliabilities (Isaac and Michael, 1978).

Validity of the Learning Predictor

The validity of a test refers to whether the obtained test scores correctly measure the variable they are supposed to measure (English and English, 1966). Validity is often discussed in terms of content, construct and predictive properties. The Learning Predictor Manual (Smith, 1980) describes the content validity of the Learning Predictor as the major consideration in the determination of validity. The following discussion of content validity is presented from the Learning Predictor Manual: "Since this instrument is designed to measure simple memory and memory coding (with a motor response) across sensory channels, the items should represent the domain of tasks normally used to accomplish these tasks and should contain commonly encountered symbols. The symbols used in the Learning Predictor represent all numbers except 0 (because of a possible confusion with the letter o) and all letters. In addition, commonly encountered shapes are employed and the items are arranged in a series of expressions that become increasingly more difficult.

The items, then, were constructed from symbols commonly encountered by the pupils during the educational process. These symbols were then put together so that they could logically measure the receptive (visual and auditory input) and expressive (motor output) behavior. Thus, the Learning Predictor is considered to have content validity"

(Smith, 1981).

Construct validity would also appear to be important in a determination of validity regarding the Learning Predictor. In this regard, the results of the Learning Predictor appear consistent with results obtained on the Receptive-Expressive Observation. As discussed earlier, the two subtests of the Learning Predictor, Auditory-Motor and Visual-Motor, were based on the two motor subtests of the Receptive-Expressive Observation. Results from both instruments indicate consistent digit span processing by pupils at the first, second, third and fourth grade levels as follows: first grade, three digits; second grade, four digits; third grade, four digits; and fourth grade, five digits (Smith, 1973 and Smith, 1981). The examination regarding digit recall between the two tests only goes to the fourth grade level because the Receptive-Expressive Observation is designed for pupils six and one-half to nine years of age, limiting the comparison to first through fourth grades. However, the digit span consistency in the grade levels discussed for the two instruments support construct validity for the Learning Predictor.

Statistical Procedures

An analysis of the computer-derived data was conducted to determine the relationship between elementary school age pupils' performance on the Visual-Motor and Auditory-Motor subtests of the Learning Predictor and their reported reading achievement. Four statistical procedures were employed in the analysis: 1) Analysis of Variance, 2) Multiple Range

Test, 3) Analysis of Covariance, and 4) Step-Wise Multiple Regression. The following discussion describes the specific statistical procedures which were utilized to test each hypothesis:

Hypothesis 1a. No difference in the means of visual perceptual recall exists among the three levels of reading achievement (below, on, and above grade level) for elementary school pupils.

Hypothesis 1b. No difference in the means of auditory perceptual recall exists among the three levels of reading achievement (below, on, and above grade level) for elementary school pupils.

The means for the three levels of reading achievement for elementary school pupils were identified in relation to their performances on the Visual-Motor and Auditory-Motor subtests of the Learning Predictor. An analysis of variance procedure was employed to determine significance of the variation in the means. The multiple-range test was then employed to test the significance in the variance in the means between each combination of reading achievement levels on the Visual-Motor and Auditory-Motor subtests as follows: below grade level with on grade level, on grade level with above grade level, and below grade level with above grade level. Tables reflecting the significance in the variance between the means as described and according to the analysis of

variance and multiple range tests are presented in Chapter IV.

Hypothesis 2. No difference in the means of visual perceptual recall exists among the three levels of reading achievement for elementary school pupils when auditory perceptual recall is held constant.

The analysis of covariance procedure was used to test the second hypothesis. This procedure allowed a pupils' performance on the Auditory-Motor subtest to be held constant, while the relationship between the means for the three levels of reading achievement and the Visual-Motor subtest performance could be tested for significance. In this manner, the independent variable of reading achievement could be examined for its affect on the dependent variable of visual perceptual recall. The tables in Chapter IV depict reading achievement as a main effect with the significance in the variation between the means on reading achievement and the Visual-Motor subtest.

Hypothesis 3. No difference in the means of auditory perceptual recall exists among the three levels of reading achievement for elementary school pupils when visual perceptual recall is held constant.

The statistical procedure utilized to test Hypothesis Three is consistent with that discussed for Hypothesis Two. The only change between Hypothesis Two and Three is the reversal of the factors to be held constant. In Hypothesis Three, the visual perceptual recall factor is held constant, while the relationship between the means for the three levels of reading achievement and the Auditory-Motor subtest performance could be examined for significance. The analysis of covariance procedure, to hold one factor constant while examining the relationship between an independent variable and a dependent variable, permits the examination of the relationship to occur with minimal contamination.

Hypothesis 4. No difference in the means of visual perceptual recall exists between grade levels for elementary school pupils when auditory perceptual recall is held constant.

Hypothesis 5. No difference in the means of auditory perceptual recall exists between grade levels for elementary school pupils when visual perceptual recall is held constant.

Hypothesis 6a. No difference in the means of visual perceptual recall exists between sexes for elementary school pupils when auditory perceptual recall is held constant.

Hypothesis 6b. No difference in the means of visual perceptual recall exists between ethnic groups for elementary school pupils when auditory perceptual recall is held constant.

Hypothesis 7a. No difference in the means of auditory perceptual recall exists between sexes for elementary school pupils when visual perceptual recall is held constant.

Hypothesis 7b. No difference in the means of auditory perceptual recall exists between ethnic groups for elementary school pupils when visual perceptual recall is held constant.

The analysis of covariance statistical procedure was used to test hypotheses four through seven. In each instance, the covariate was held constant, while the relationship between the other dependent and independent variables was assessed. The independent variables of grade level, sex and ethnicity were included within the study. Each of these independent variables was dichotomized to facilitate the application of the analysis of covariance statistical procedure as follows:

1) Grade level; primary grades (1, 2 and 3) versus intermediate grades (4, 5 and 6).

2) Sex: male versus female.

3) Ethnicity: Caucasian versus all others including Spanish/ Mexican, Black and Asian.

Data from the tables in Chapter IV reflect the significance of the relationship between the means for each group's performance (independent variable classification) on the Visual-Motor subtest or Auditory-Motor subtest appropriate for each hypothesis. The main effects were studied separately for each hypothesis. In addition, the joint effect was investigated with two, three, and four independent variables on each dependent variable. Results of the joint effect analysis are presented in Chapter IV of the document.

A fourth statistical procedure was applied to the research to provide additional information and clarify the differences between the factors under discussion and the dependent variables. The step-wise multiple regression analysis provided information regarding the predictability of the factors on the dependent variables. This statistical procedure allowed the results of the study to be discussed in relationship to the percentage of the variation in score for the dependent variables that could be accounted for by a specific independent variable. The results of this statistical procedure are presented as additional analysis information in Chapter IV.

The SPSS programs were used in completing each of the statistical procedures described. A .05 level of significance was employed for this study.

Summary

The research design of this study focused on the relationship of pupils' performances on the Learning Predictor and the pupils' level of achievement in reading. The perceptual ability of a pupil on the Learning Predictor was examined in relation to the two subtests of Visual-Motor and Auditory-Motor. Reading achievement was evaluated by the classroom teacher's ratings of below grade level, on grade level or above grade level attainment for each pupil. The classroom teacher also furnished information relating to grade placement, ethnicity and sex for each pupil. These factors were then also examined for their relationship to the perceptual recall skills of auditory-motor and visual-motor.

The study was conducted with 1,011 elementary grade level pupils in northern California. The description of the Learning Predictor discusses the characteristics of the instrument, as well as the reliability and validity of the Learning Predictor. Identifying information was also collected for each pupil in accordance with the procedures described. The data were then subjected to statistical analysis by four major methods; analysis of variance, analysis of covariance, multiple range test and a step-wise multiple regression. The application of these four analysis methods allowed each hypothesis to be tested as presented in Chapter IV.

Chapter IV

RESULTS OF THE STUDY

Chapter IV presents each hypothesis and the statistical results of applying research techniques to data obtained from the Learning Predictor test scores, when compared with the factors of personal information about the subjects.

The results were analyzed to determine first, whether or not there was a significant relationship between reading achievement and visual/auditory perceptual recall abilities; and second, whether or not the factors of grade level, sex and ethnicity were also significant in the relationship. The information in this Chapter was analyzed through four different methods. 1) An analysis of the variance, 2) Multiple range test, 3) An analysis of covariance, and 4) A step-wise multiple regression methodology.

This Chapter presents the statistical information relating to each hypothesis, a discussion of the results, and a summary of the findings. Information for the additional analysis is also presented with an explanation of the data as they compare to the seven hypotheses originally generated.

Presentation of Findings

Hypothesis 1a. No difference in the means of visual

perceptual recall exists among the three levels of reading achievement (below, on, and above grade level) for elementary school pupils.

The null hypothesis was rejected. Statistically, when visual perceptual recall levels were compared with reading achievement levels, a significant difference did appear as presented in the following table:

Table 3

SUMMARY FOR THE ANALYSIS OF VARIANCE OF VISUAL PERCEPTUAL RECALL FOR THE THREE LEVELS OF READING ACHIEVEMENT

SOURCE	SS	DF	MS	F	p
READING ACHIEVEMENT LEVELS					
BETWEEN LEVELS	900.442	2	450.221	43.283	0.0000
WITHIN LEVELS	11108.994	1068	10.402		
TOTAL	12009.436	1070			

Generally, the data indicated that as reading achievement levels increased, a corresponding increase in visual perceptual recall performance was noted. However, a specific analysis was completed to determine if a significant variation in the means existed between each pair-wise combination of the three levels of reading achievement. The following

table presents the results from the multiple range test:

Table 4

SUMMARY OF THE MULTIPLE RANGE TEST FOR VISUAL PERCEPTUAL RECALL AMONG THE THREE LEVELS OF READING ACHIEVEMENT FOR EACH PAIR-WISE COMPARISON

	Differences Between Means		
	Below Grade Level	On Grade Level	Above Grade Level
Below Grade Level (12.97)	0	1.0403*	2.3884*
On Grade Level (14.01)	1.0403*	0	1.3481*
Above Grade Level (15.36)	2.3884*	1.3481*	0

*Significant at the 0.05 Level.

Pupils who were identified by the classroom teacher as below grade level in reading achievement had a mean of 12.97 out of a possible twenty-four items on the Learning Predictor Visual-Motor subtest. The on-grade level readers had a mean of 14.01 and the above grade level readers scored with a mean of 15.36 on the Visual-Motor subtest. As indicated in Table 4, the difference between the means for each of the combinations of reading achievement was significant at the 0.05 level. Therefore, the relationship depicted in the analysis of variance held true for each pair-wise combination of reading achievement on the Visual-Motor subtest.

Hypothesis 1b. No difference in the means of auditory

perceptual recall exists among the three levels of reading achievement (below, on, and above grade level) for elementary school pupils.

The data showed a significant difference between the levels of reading achievement and auditory perceptual recall skills. The information depicted in the following table indicates that the null hypothesis was rejected.

Table 5

SUMMARY FOR THE ANALYSIS OF VARIANCE OF AUDITORY PERCEPTUAL RECALL FOR THE THREE LEVELS OF READING ACHIEVEMENT

SOURCE	SS	DF	MS	F	p
READING ACHIEVEMENT LEVELS					
BETWEEN LEVELS	492.514	2	246.257	26.940	0.0000
WITHIN LEVELS	9762.367	1068	9.141		
TOTAL	10254.881	1070			

The following table presents the results of the multiple range test:

Table 6

SUMMARY OF THE MULTIPLE RANGE TEST FOR AUDITORY PERCEPTUAL RECALL AMONG THE THREE LEVELS OF READING ACHIEVEMENT FOR EACH COMPARISON

	Differences Between Means		
	Below Grade Level	On Grade Level	Above Grade Level
Below Grade Level (12.32)	0	1.0243*	1.7997*
On Grade Level (13.34)	1.0243*	0	0.7744*
Above Grade Level (14.12)	1.7997*	0.7744*	0

*Significant at the 0.05 Level.

Figures indicated that below grade level readers correctly respond to an average of 12.32 items on the Auditory-Motor subtest of the Learning Predictor. On-grade level readers correctly answered 13.34 items and above grade level readers scored an average of 14.12 on the instrument. The difference between each level of reading achievement was statistically significant, as measured by the multiple range test.

Hypothesis 2. No difference in the means of visual perceptual recall exists among the three levels of reading achievement for elementary school pupils when auditory perceptual recall is held constant.

Hypothesis two, when presented in a null statement, was rejected. A level of probability less than .01 demonstrated that a measurable relationship existed between the means for the levels of reading achievement and visual perceptual recall when auditory perceptual recall was held constant. The following table presents the salient data for hypotheses two, four and six.

Table 7

SUMMARY OF THE ANALYSIS OF COVARIANCE FOR VISUAL PERCEPTUAL RECALL FOR THE FACTORS OF READING ACHIEVEMENT, GRADE LEVEL, SEX AND ETHNICITY, WITH AUDITORY PERCEPTUAL RECALL AS THE COVARIATE

SOURCE OF VARIATION	ADJ. SS	DF	ADJ. MS	F	p
COVARIATES	4331.692	1	4331.692	842.128	0.000
AUDITORY PERCEPTUAL RECALL	4331.692	1	4331.692	842.128	0.000
MAIN EFFECTS	2005.940	5	401.188	77.995	0.000
GRADE LEVEL	1691.219	1	1691.219	328.791	0.000
SEX	1.836	1	1.836	0.357	0.550
ETHNICITY (ETH)	52.746	1	52.746	10.254	0.001
READING ACHIEVEMENT (RA)	304.346	2	152.173	29.584	0.000
2-WAY INTERACTIONS	62.835	9	6.982	1.357	0.203
GRADE SEX	0.033	1	0.033	0.006	0.936
GRADE ETHNIC	0.307	1	0.307	0.060	0.807
GRADE RA	8.786	2	4.393	0.854	0.426
SEX ETHNIC	0.169	1	0.169	0.033	0.856
SEX RA	1.999	2	0.999	0.194	0.823
ETHNIC RA	52.524	2	26.262	5.106	0.006
3-WAY INTERACTIONS	44.672	7	6.382	1.241	0.277
GRADE SEX ETH	3.473	1	3.473	0.675	0.411
GRADE SEX RA	20.707	2	10.354	2.013	0.134
GRADE ETHNIC RA	14.197	2	7.099	1.380	0.252
SEX ETHNIC RA	6.267	2	3.133	0.609	0.544
4-WAY INTERACTIONS	20.777	2	10.389	2.020	0.133
GRADE SEX ETH RA	20.777	2	10.398	2.020	0.133
EXPLAINED	6465.917	24	269.413	52.377	0.000
RESIDUAL	5071.733	986	5.144		
TOTAL	11537.650	1010	11.423		

Variation in the mean scores of the three reading levels occurred when auditory perceptual recall was held constant. Results from the analysis of covariance indicated that below grade level readers scored an average of 12.98; on grade level readers scored 14.05 on the average; and above grade level readers reported average scores of 15.37. The relationship discussed for the visual perceptual recall performance corresponding to the reading achievement level continued, regardless of the statistical methodology.

Hypothesis 3. No difference in the means of auditory perceptual recall exists among the three levels of reading achievement for elementary school pupils when visual perceptual recall is held constant.

Data showed that the null hypothesis was rejected and a level of significance of .01 was established. Data within the following table present the relationships established and salient to hypotheses three, five and seven:

Table 8

SUMMARY OF THE ANALYSIS OF COVARIANCE FOR AUDITORY PERCEPTUAL RECALL FOR THE FACTORS OF READING ACHIEVEMENT, GRADE LEVEL, SEX AND ETHNICITY WITH VISUAL PERCEPTUAL RECALL AS THE COVARIATE

SOURCE OF VARIATION	ADJ. SS	DF	ADJ. MS	F	p
COVARIATES	3692.837	1	3692.837	623.743	0.000
VISUAL PERCEPTUAL RECALL	3692.837	1	3692.837	623.743	0.000
MAIN EFFECTS	218.627	5	43.725	7.386	0.000
GRADE LEVEL	172.532	1	172.532	29.142	0.000
SEX	16.733	1	16.733	2.826	0.093
ETHNICITY (ETH)	0.001	1	0.001	0.000	0.991
READING ACHIEVEMENT (RA)	54.078	2	27.039	4.567	0.011
2-WAY INTERACTIONS	34.191	9	3.799	0.642	0.762
GRADE SEX	6.571	1	6.571	1.110	0.292
GRADE ETH	0.000	1	0.000	0.000	0.994
GRADE RA	3.405	2	1.702	0.288	0.750
SEX ETH	9.504	1	9.504	1.605	0.205
SEX RA	8.982	2	4.491	0.759	0.469
ETH RA	6.045	2	3.022	0.511	0.600
3-WAY INTERACTIONS	15.992	7	2.285	0.386	0.911
GRADE SEX ETH	4.605	1	4.605	0.778	0.378
GRADE SEX RA	0.556	2	0.278	0.047	0.954
GRADE ETH RA	0.713	1	0.356	0.060	0.942
SEX ETH RA	10.385	2	5.193	0.877	0.416
4-WAY INTERACTIONS	36.820	2	18.410	3.110	0.045
GRADE SEX ETH RA	36.821	2	18.410	3.110	0.045
EXPLAINED	3998.469	24	166.603	28.140	0.000
RESIDUAL	5837.563	986	5.920		
TOTAL	9836.031	1010	9.739		

An examination of the relationship of reading achievement to auditory perceptual recall yields a statistically significant correlation. As noted in previous discussions, below grade level readers tend to score lower on the perceptual recall measure than above grade level readers. The relationship continued to be valid on the auditory perceptual recall scores, with low readers scoring 12.39, on-grade level readers scoring 13.71, and high readers scoring 14.16 on the average.

Hypothesis 4. No difference in the means of visual perceptual recall exists between grade levels for elementary school pupils when auditory perceptual recall is held constant.

The null hypothesis was rejected as reflected by the data in Table 7. Grade level was treated as an independent variable with focus upon two groups of primary grades (1, 2 and 3) and intermediate grades (4, 5 and 6). The effect of the independent variable was thus studied as it related to the dependent variable of visual perceptual recall. A statistically significant relationship was established at a level less than .01. This indicates that as pupils mature, they are able to expand their digit span or capacity for recalling information presented through the visual channel. As expected, pupils in primary grades scored lower than pupils in intermediate grades. Primary grade pupils averaged 11.74 points on the Learning Predictor, Visual-Motor subtest, while an average score of 16.00 was obtained by pupils in the intermediate grades.

Hypothesis 5. No difference in the means of auditory perceptual recall exists between grade levels for elementary school pupils when visual perceptual recall is held constant.

Research data indicated that a significant relationship exists between grade level and auditory perceptual recall. Data within Table 8 present information which resulted in the rejection of the null hypothesis.

Overall, pupils scored slightly lower on the Auditory-Motor subtest than the Visual-Motor subtest of the Learning Predictor. Primary students averaged 11.65 and intermediate students averaged 14.66 items correctly answered. The variation between the two groups and their scores on the perceptual measure was statistically significant at a level greater than .01. These results appear consistent with the discussion presented regarding visual perceptual recall.

Hypothesis 6a. No difference in the means of visual perceptual recall exists between sexes for elementary school pupils when auditory perceptual recall is held constant.

The results of the research failed to reject the null hypothesis as was presented in Table 7. Minimal discrepancy in performance on the

visual perceptual recall instrument was noted between male and female pupils. The mean score of male pupils was 14.12, while the mean score of female pupils was 14.37. The deviation was not significant as determined by analysis of covariance.

Hypothesis 6b. No difference in the means of visual perceptual recall exists between ethnicity for elementary school pupils when auditory perceptual recall is held constant.

The null hypothesis was rejected. A statistically significant relationship was found to exist between the independent variable of ethnicity and visual perceptual recall as was depicted by data in Table 7.

The independent variable of ethnicity was treated in a dichotomy of Anglo-American pupils and minority pupils. The minority pupils included Black individuals, Spanish-surnamed individuals and Asian individuals. On the visual perceptual recall measure, minority pupils were found to score an average of 1.27 lower than Anglo-American pupils. Mean scores of 13.13 for minority pupils, and 14.40 for Anglo-American pupils were found. This differentiation in scores was determined to be statistically significant with an analysis of covariance.

Hypothesis 7a. No difference in the means of auditory

perceptual recall exists between sexes for elementary school pupils when visual perceptual recall is held constant.

As previously reported on the visual perceptual recall discussion, the results of the study failed to reject the null hypothesis as stated. Data within Table 8 present the information salient to this hypothesis.

An average of 0.32 points separated male pupils and female pupils on the Learning Predictor Auditory-Motor subtest. There did not appear to be a statistically significant relationship between the sex of an individual and their performance on the auditory perceptual recall measure. These results are consistent, that sex does not affect perceptual recall skill regardless of the input modality of visual or auditory.

Hypothesis 7b. No difference in the means of auditory perceptual recall exists between ethnicity for elementary school pupils when visual perceptual recall is held constant.

The null hypothesis failed to be rejected from the data reported on Table 8. The auditory perceptual recall measure did not statistically differentiate in the means of the performance of Anglo-American pupils and the performance of pupils from a minority ethnic group when visual

perceptual recall was held constant. Less than one point separated their respective unadjusted means of 13.50 (Anglo-American pupils) and 12.83 (Spanish/Mexican, Black and Asian pupils). The difference between the means on visual perceptual recall of the two ethnic groups was greater than that attained on auditory perceptual recall. Therefore, when the means for the auditory perceptual recall were adjusted and visual perceptual recall was treated as a covariate, the difference between the means on auditory perceptual recall of the two ethnic groups was not found to be statistically significant.

Summary of Findings

Seven hypotheses were generated to investigate the relationship between measures of perceptual recall and other factors. The factors of reading achievement, grade level, sex and ethnicity were utilized in this study. The measure of perceptual recall examined the reception of information through both visual and auditory channels. The first hypothesis was found to indicate that a significant difference existed between the factor of reading achievement and the dependent variables of visual perceptual recall and auditory perceptual recall. In addition, a relationship was established at a statistically significant level between the factor of reading achievement and each dependent variable, when the other dependent variable was held constant. This relationship was explored and documented in the second and third hypotheses.

The fourth and fifth hypotheses, exploring the relationship of

grade level to each dependent variable, when the other dependent variable was held constant, was validated. A statistical significant relationship was indicated in the findings of this study.

The findings regarding the factor of ethnicity with the measures of perceptual recall appear inconsistent. Origin of ethnicity to visual perceptual recall was indicated at a statistically significant level. However, a statistically significant relationship was not documented in the study between ethnicity and auditory perceptual recall when visual perceptual recall is held constant. These results were noted in the hypotheses six and seven.

The final two hypotheses also indicated that there was no statistical significant relationship between sex and either dependent variable. The factor of sex did not appear to affect the performance of a pupil on the visual perceptual reall or auditory perceptual recall measures.

Additional Analysis

In an attempt to further clarify the relationship that could occur between the factors under discussion and the dependent variables noted, a step-wise multiple regression analysis was completed. Information presented through this method of analysis assisted in determining the predictability of the factors on the dependent variables.

When the visual perceptual recall dependent variable was examined, it was determined that the independent variables accounted for .54897 of the variation in score. The step-wise multiple regression presented data in a hierarchial manner which presented the independent variable accounting for the greatest variation through the independent variable accounting for the least. The results of the analysis indicated the following order: 1) Grade level, 2) Auditory perceptual recall, 3) Reading achievement, 4) Ethnicity and 5) Sex. Data within the following table presents the information obtained for visual perception:

Table 9

STEP-WISE MULTIPLE REGRESSION ANALYSIS OF VISUAL PERCEPTUAL RECALL FOR THE VARIABLES OF GRADE LEVEL, AUDITORY PERCEPTUAL RECALL, READING ACHIEVEMENT, ETHNICITY AND SEX

VARIABLE	Multiple R	F
Step 1: Grade Level	.62167	635.60*
Step 2: Auditory Perceptual Recall	.71873	538.54*
Step 3: Reading Achievement	.73780	401.02*
Step 4: Ethnicity	.74080	305.89*
Step 5: Sex	.74092	244.65*

*Significant at the 0.01 Level.

SUMMARY OF THE STEP-WISE MULTIPLE REGRESSION ANALYSIS FOR VISUAL PERCEPTUAL RECALL

VARIABLE	R Square	RSQ Change
Grade Level	0.38648	0.38648
Auditory Perceptual Recall	0.51657	0.14009
Reading Achievement	0.54436	0.02779
Ethnicity	0.54879	0.00443
Sex	0.54897	0.00018

As data within the table indicates, grade level accounted for the greatest variation in the visual perceptual recall variable. The prediction of performance on the visual perceptual recall measure is heightened to .51657 with the addition of the factor of auditory perceptual recall. This was not examined in the original hypotheses and discussion, but the information obtained was significant and is therefore reported. The results of this analysis tend to support the concept of a relationship between the two dependent variables.

Therefore, it appeared important that in the original statistical analysis a methodology was employed which held constant one of the dependent variables while examining the other.

The independent variables of grade level and auditory perceptual recall account for the greatest proportion of the variation in visual perceptual recall. The additions of the factors of reading achievement, ethnicity and sex only add .03240 beyond the initial two factors.

From the information presented, the factors of reading achievement, ethnicity and sex do not contribute information to the same degree that is present in the initial two factors. However, each of the independent variables treated in this step-wise multiple regressive analysis are statistically significant in relation to the dependent variable of visual perceptual recall.

When the auditory perceptual recall dependent variable was

examined, only four of the independent variables significantly affected the variation. Visual perceptual recall, grade level, reading achievement and sex in a hierarchial sequence accounted for .39634 of the variation. Data within the following table present the findings for auditory perception:

Table 10

STEP-WISE MULTIPLE REGRESSION ANALYSIS OF AUDITORY PERCEPTUAL RECALL FOR THE VARIABLES OF VISUAL PERCEPTUAL RECALL, GRADE LEVEL, READING ACHIEVEMENT AND SEX

VARIABLE	Multiple R	F
Step 1: Visual Perceptual Recall	.61273	606.53*
Step 2: Grade Level	.62442	322.09*
Step 3: Reading Achievement	.62829	218.92*
Step 4: Sex	.62955	165.12*

*Significant at the 0.01 Level.

SUMMARY OF THE STEP-WISE MULTIPLE REGRESSION ANALYSIS FOR AUDITORY PERCEPTUAL RECALL

VARIABLE	R Square	RSQ Change
Visual	0.37544	0.37544
Grade Level	0.38990	0.01446
Reading Achievement	0.39474	0.00485
Sex	0.39634	0.00159
(Constant)		

The independent variable which accounted greatest for the variation in the auditory perceptual recall dependent variable was visual

perceptual recall. Grade level, reading achievement and sex only added .0209 in their cumulative effect. The independent variable of ethnicity did not contribute in a statistically significant manner to the dependent variable of auditory perceptual recall. The F-level or tolerance level, was insufficient to accommodate further computations for this factor. Therefore, the data is omitted from the presentation in table form.

The factors of grade level, auditory perceptual recall, reading achievement, ethnicity, and sex accounted for a larger degree of the variation (.54897) in scores for visual perceptual recall; than the factors of visual perceptual recall, grade level, reading achievement, and sex accounted for in the variation (.39634) of scores for auditory perceptual recall. However, the variation within the dependent variable of auditory perceptual recall is accounted for at a statistically significant level with each of the independent variables cited. With the exception of the ethnicity factor, this is consistent with the results obtained for the visual perceptual recall dependent variable.

The examination of the ethnicity factor and its impact upon the dependent variable of visual perceptual recall and auditory perceptual recall is consistent with the information reported earlier for hypotheses six and seven. The ethnicity factor did not relate to auditory perceptual recall, but a relationship was depicted with visual perceptual recall.

Interpretation of Findings

A review of the results presented lead to the following conclusions: 1) Pupils who are rated as better readers, also process greater amounts of information through both visual and auditory modalities; 2) As pupils mature, their perceptual processing abilities also improve; 3) The sex of a pupil does not affect perceptual recall abilities; 4) The Learning Predictor Auditory-Motor perceptual recall measure is not affected by the ethnicity of a pupil when you control for visual perceptual recall while the Visual-Motor subtest scores are affected by the ethnicity of a pupil; 5) Pupils can correctly sequence more information presented visually than information presented through the auditory channel; 6) The skills of auditory perceptual recall and visual perceptual recall appear related.

Findings Regarding Reading Achievement

The findings of the study indicated that a relationship exists between perceptual recall abilities and a pupils' reading level. It was determined through the course of the study, that pupils' rated as being above grade level readers also processed information more efficiently than on grade level or below grade level readers. The hierarchial relationship was valid at each level, including the finding that poor readers processed information inefficiently or at a level below the norm. Pupils who were rated by their teachers as reading below grade level were found to also have visual and auditory perceptual recall skills

below the norm of their classmates. This finding may lend support to the supposition that perceptual recall functioning is a basic skill or contributing skill to reading achievement.

The study did not attempt to examine the methodology of teaching reading, or the strength-deficit question described in Chapter II. Therefore, conclusions cannot be formed in those areas based on the research completed in this study. However, the findings are consistent with an increase in perceptual skills and may have a relationship to a corresponding increase in reading achievement. To determine the specific nature of the relationship would appear to warrant further study.

Findings Regarding Grade Level

It was found that pupils in each successive grade could process a greater amount of information than those pupils in the grade below them. Generally, the findings indicated that on the norm; first grade could process three pieces of information; second grade could process four pieces of information; third grade could process between four and five pieces of information; fourth and fifth graders could process five pieces of information; and sixth grade could process between five and six pieces of information. The determination of grade appropriate processing levels for visual and auditory stimuli would appear particularly salient to classroom curriculum, teaching style and presentation methods. The results of this study would suggest that pupils in the first grade should only be presented with three directions on an automatic level through the auditory channel,

at one time. Therefore, a teacher of the first grade may wish to restrict the amount of verbal directions given to the class, to the appropriate level, in order to insure that most pupils are receiving and processing the information correctly on the automatic level. This example would be applied to the other grade levels and to both visual and auditory channels.

In addition to adjusting curriculum and teaching style in the classroom, the finding of the relationship between grade level and perceptual recall skills allows for the identification of pupils functioning above or below the norm. By establishing normative data for visual and auditory perceptual recall, pupils can be evaluated and compared to the norm. The results of the pupil evaluation can then be useful in assisting in the explanation of behaviors and academic performance. A pupil who cannot process as much information as would be consistent with his/her grade level, may ask to have directions repeated several times, in order to comprehend the series. Determining the level of perceptual recall may assist the teacher in understanding the behavior being exhibited and perhaps suggest remediation techniques or interventions to change the behavior.

Findings Regarding the Sex of Pupils

An examination of how sex affects perceptual recall abilities reveals little difference between boys' and girls' scores. On both the visual and auditory perceptual recall measures, the sex of the pupils did not affect the performance level of the pupil. This suggests that

the skill is not sexually biased. Therefore, when a pupil is evaluated as deviating from the norm on the perceptual recall measure, attention does not need to be focused on the sex of the pupil.

Findings Regarding Ethnicity

The findings in the area of ethnicity were less conclusive. The ethnicity of the pupil did not affect their performance at a statistically significant level on the Auditory-Motor subtest of the Learning Predictor, when visual perceptual recall was held constant. However, on the Visual-Motor subtest, minority pupils were found to score at a statistically significant lower level than Caucasian pupils. This finding may be related to: 1) The experiental backgound of the minority pupils; 2) The design of the study which combined the three ethnic groups; 3) An incidence of chance in the particular subjects tested; 4) Another causal factor not measured or accounted for in the study, such as intelligence, socio-economic status of the subject, etc.; 5) The test is ethnically biased; or 6) An unknown quantity. This study cannot document the reason or nature of the relationship shown to exist. However, further research would appear helpful to resolve the questions posed by the relationships indicated.

Findings Regarding Visual and Auditory Processing Levels

The findings of this study indicated that students generally score higher on visually presented stimuli, than on the instrument measuring the auditory channel. The results note that on the average, elementary school

pupils can correctly sequence and recall a greater amount of information presented to them through the visual modality than through the auditory modality. This finding related to the Learning Predictor is inconsistent with the norms established on the Receptive-Expressive Observation (Smith, 1974). The data indicated from the Learning Predictor that a greater number of pieces of information could be processed when the information was presented visually than when the input channel was through the ears. Further research may be helpful in determining the source of inconsistency between the two instruments.

Findings Regarding the Relationship Between Visual and Auditory Perceptual Recall

A relationship between the two input channels was a finding of this study. The perceptual recall skill (either visual or auditory) was found to account for a significant degree of variation in the other respective dependent variable. In other words, visual perceptual recall explained a significant portion of the auditory perceptual recall scores, and auditory perceptual recall explained a significant portion of the visual perceptual recall scores. This finding, indicating a relationship between the two input modalities, is consistent with the concept that perceptual recall may be a skill or ability independent of the channel used to receive information. Based on this concept, for normal pupils, perceptual recall would be considered a developmental skill allowing the pupil to process a certain amount of information, regardless of the channel used to input that information. If this supposition is true,

then for a pupil deviating from the norm in only one channel, the prognosis for remediation appears more positive than if a pupil is below the norm in both visual and auditory functioning. The rationale for this statement is that if the perceptual recall skill is not developed, chances for increasing that skill are less than if it is partially developed, but in only one modality. The validity of the supposition and the subsequent value to diagnosticians and educators remains to be proven in further research.

Summary

Chapter IV has included the findings of the study through the four methods of analysis that were employed: 1) analysis of variance. 2) the multiple range test, 3) the analysis of covariance, and 4) a stepwise multiple regression. Each hypothesis was studied in relation to the results obtained for the statistical analysis. As discussed throughout Chapter IV, a significant difference between the means for elementary school pupils' performances was shown on auditory and visual perceptual recall with reading achievement and grade level. No significant relationship was demonstrated between the means for elementary school pupils' performance and auditory and visual perceptual recall with the factor of sex. The results regarding ethnicity were mixed. The factor of ethnicity was found to correlate with visual perceptual recall, but not with auditory perceptual recall, when visual perceptual recall was held constant.

The discussion of the step-wise multiple regression analysis indicated a correlation between auditory perceptual recall and visual perceptual recall. The discovery of this relationship was discussed in the interpretation of findings as a significant result of the study.

Chapter V

SUMMARY OF THE STUDY

Chapter V has been divided into three sections to summarize and conclude the study. These are as follows:

1. Summary discussion of the study;
2. The conclusions and recommendations of the study; and
3. A listing of suggestions for further research.

Summary Of The Study

This study was undertaken to explore the relationship between perceptual recall abilities and academic performance in the area of reading.

The nature of the perceptual recall to be examined was a digit span approach with both visual-motor and auditory-motor modalities included. The study examined the relationship between pupils' performance on the group sensory instrument, the Learning Predictor, and the pupils' standing in reading achievement of above, on, or below grade level.

A large sample of 1,011 pupils from three elementary schools in Sacramento County was included within the study. Each pupil was administered the Learning Predictor. Code sheets were completed with identifying information for each pupil assessed. Grade level, school name, sex

ethnicity, and the reading achievement level were recorded for each pupil by a code number. The test forms were also marked to match the code number for each pupil. This procedure was used to protect the confidentiality of all pupils participating.

The data gathered on individual pupils facilitated a study of the relationship of each factor to the pupil's performance on the Learning Predictor. The affect of gender, grade level, and ethnicity of a pupil was explored through a statistical analysis. The relationship of reading achievement for elementary school pupils to perceptual recall functioning was also examined in detail. One final analysis was accommodated through the methodology employed, a study of the relationship between the two modalities of visual perceptual recall and auditory perceptual recall.

These areas of inquiry appeared appropriate and necessary in the field of education for the following reasons:

1. Research conducted previously regarding perceptual skills and academic performance, had not defined perceptual skills specifically as digit span in the visual and auditory modalities. Previous research had often included fine motor, gross motor, discrimination, figure-ground, as well as other factors in perceptual skill definitions.

2. Previous research had examined the relationship question in the form of perceptual skill ability and the results of a methodology in teaching reading. Further research appeared necessary to examine the level of attainment of reading achievement and perceptual skill ability,

without regard to the methodology of teaching style.

3. The perceptual recall or modality capacity model has widespread appeal, to many educators, as a method of providing remedial programming. The impact of this model and use as a remediation technique indicates a need for empirical research documentation to support continued use of perceptual skill training.

4. Legislation has been enacted in California requiring students to meet minimum proficiencies prior to graduation from high school. This supports the need for research to examine any factor thought to be salient to the academic performance of pupils. Research which would assist in discovering techniques to increase efficiency in learning and to maximize academic achievement would appear crucial at this time.

5. In order for a study which involves the measurement of perceptual recall abilities to yield results which will be of assistance to educators, the researcher must also attend to considerations regarding:

a) A standardized measurement;

b) Cost effectiveness;

c) Personnel training requirements for administration;

d) Time requirements for administration; and

e) Usefulness of the results.

The Learning Predictor was used in this study because it addressed

the concerns in these areas. The Learning Predictor is a group standardized instrument which is able to be administered by a classroom teacher in approximately fifteen to twenty minutes. The lack of suitable instruments had previously precluded a study which could provide data in the manner prescribed.

6. Recent court decisions regarding the affect of ethnicity on assessment results and subsequent placement decisions regarding pupils supports the need for further research in this area. Therefore, ethnicity was a factor included within the study.

These reasons for conducting the study also contributed to the specific design of the study. They formed the basis for the examination and contributed to the hypotheses generated. The conclusions and recommendations from the study then follow.

Conclusions and Recommendations

The results of this study indicated that a significant positive relationship exists between perceptual recall skills and reading achievement for elementary school pupils. Data also established that below grade level readers have difficulty in processing both visual and auditory stimuli. The results of the study also noted that as reading achievement increased, a corresponding increase in perceptual recall skills can be found. This finding provides the initial step and basis for establishing perceptual recall skills as a basic function in academic achievement. If perceptual skills were determined to be a basic function, this would

indicate that a pupil would need to have appropriate visual and auditory processing skills before success in academic pursuits could be anticipated. Being able to receive, to process and to respond in an appropriate manner would seemingly remove the handicap caused by a lack of perceptual skills. Being able to perceptually process information would not translate into meaning that attainment of perceptual recall skills would automatically guarantee academic success. Many other skills also contribute to success in the school setting. One of these skills may be mental ability which was not examined in this study.

Conclusions and Recommendations Regarding Reading Achievement

The data obtained support the conclusion that pupils who do not process the appropriate amount of information are likely to have difficulty academically. The relationship of reading achievement was studied with both visual and auditory perceptual recall skills. Regardless of the input modality, poor readers had difficulty processing the appropriate amount of stimuli commensurate with their age. The statistical analysis employed facilitated the examination of the relationship between dependent variables, while holding the other dependent variable constant. In each analysis, a positive relationship was established between visual perceptual recall and reading achievement and between auditory perceptual recall and reading achievement. The establishment of the positive relationship among reading achievement and visual and auditory perceptual recall skills suggests that reading may not be purely a single modality task. This is salient to the strength-deficit question, as well as to a

contention that reading can be taught through one or the other modality. Further research may indicate that both channels are necessary for reading achievement to be maximized.

Conclusions and Recommendations Regarding Grade Level

The finding of a relationship between grade level and the perceptual recall skill levels establishes information useful to the classroom teacher. By establishing norms regarding the amount of information each pupil should be processing in the classroom, the teacher can provide visual and auditory stimuli at the appropriate level. The finding that pupils can generally process a greater amount of information through the visual channel than the auditory channel, also assists the teacher in providing stimuli at an appropriate level.

A recommendation resulting from this study would be that classroom teachers examine reading instruction and curriculum in order to assure that the amount of stimuli being presented is consistent with the grade level norms for processing levels. The reading materials used should only have an expectation that the pupil process as much information as would be indicated for that grade level. If expectations are higher, it would appear probable that a majority of the pupils in the class will experience learning difficulty.

Conclusions and Recommendations Regarding Gender

The findings in the area of the relationship between sex and

perceptual recall skills, indicated that channel proficiency was not shown to be linked to the gender of the pupil. This leads to the conclusion that attention may not be necessary regarding the gender of the pupil in remediating perceptual deficits.

Conclusions and Recommendations Regarding Ethnicity

A statistically significant relationship was found to exist between ethnicity and visual perceptual recall skills, but not between ethnicity and auditory perceptual skills, when visual perceptual recall was held constant. Possible explanations regarding the relationship between ethnicity and visual perceptual recall skills were set forth in Chapter IV. However, until such time as research provides further illumination on this question, scores on the Visual-Motor Subtest of the Learning Predictor must be regarded with care for minority pupils.

Conclusions and Recommendations Regarding Visual and Auditory Perceptual Recall

A relationship between visual perceptual recall skills and auditory perceptual recall skills was discovered during the course of this study. The existence of this relationship leads to the hypothesis that pupils diagnosed as experiencing a deficit in one channel would be easier to remediate than pupils demonstrating a deficit in both perceptual channels.

The relationship between the two perceptual recall skills would

also significantly affect the strength-deficit issue discussed in Chapter II. Questions relating to whether to provide instruction in one channel while trying to remediate the other, would not appear as crucial if, in fact, the two channels are significantly related.

Suggestions For Further Research

The completion of this study answered preliminary questions regarding perceptual skills and reading achievement and posed many more regarding the nature of learning. Further research is suggested in a number of areas relating to the affect other factors have on perceptual recall skills. These include:

1. Studies investigating factors such as intelligence, socio-economic status, and others and their affect on perceptual recall performance.

2. Studies examining relationship between other subject matter, such as math, spelling, language, etc., and perceptual recall skills.

3. The factor of pupil behavior and the relationship to perceptual recall skills.

Reading achievement was defined and examined in a particular manner within this study. Further research would appear warranted to expand the findings in this area. These include:

1. Studies utilizing standardized reading achievement scores or another rating instrument to provide a more precise measure of reading achievement.

2. Studies investigating the relationship of reading achievement to perceptual recall skills utilizing alternative instruments to measure modality capacity.

3. Research studies examining reading achievement and other factors of perceptual skills, such as discrimination, fine motor, gross motor, figure-ground, closure, etc.

The findings of this study regarding the relationship of ethnicity to perceptual recall skills leads to the following areas of further research:

1. Studies determining precisely the nature of the relationship between ethnicity and the measurement of perceptual recall skills.

2. Studies examining each ethnic group and their performance on perceptual recall measures.

This study also provides preliminary data regarding the relationship between reading achievement and perceptual recall skills. Further research is needed to document the conclusion that perceptual recall skills are a basic skill to reading achievement. These include:

1. Studies to investigate the effect of remediating perceptual skill areas prior to remedial academic instruction.

2. Studies utilizing other achievement tests and the Learning Predictor.

The relationship between the visual modality and the auditory

modality was examined in this study. Further research in this specific area may include:

1. Studies to determine the nature of the relationship between auditory and visual perception.

2. Studies conducted to investigate the relationship between pupils with one channel deficit versus pupils with two channel deficits with their level of reading achievement.

3. Studies aimed at examining the ratio of remediation for pupils with one channel deficit and pupils with two channel deficits.

4. Studies to investigate the effect of training both perceptual channels and the teaching of reading.

These additional areas of inquiry with this study, would continue the contributions being made to the body of knowledge regarding learning. Findings in each of these areas may eventually lead to the answer of how to maximize the learning potential for each pupil. However, until those questions are answered, educators must continue in their commitment to serve all individuals with the most appropriate methods and techniques known.

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APPENDIX

APPENDIX A

SCORING SHEET CODES

CODE	Number assigned to each pupil
Age	Age of pupil in months. (Fill left zeros)
PF	Performance of pupil in other academic work (reading) as determined by the teacher. 1=Below grade level 2=Average level 3=Above other pupils
ET	Ethnic information for each pupil: Anglo/American=if blank, use 0. Spanish/Mexican=1 Black=2 Asian=3
GR	Grade level of each pupil. (01-12)
SHL	School of attendance for each pupil: Sierra View=1.1 Hillsdale=1.2 Schweitzer=2.1 Will Rogers=2.2 Del Campo=2.3 Curtis=3.1 Milpitas=3.2 Ayer=3.3
MF	Sex identification data: Male=1, Female=2
c	Correct response.
p	Perseveration error.
s	Seriation error.
d	Digit span error.
r	Reversal error.
nr	No response.
o	Other type of error.

APPENDIX B

KEY PUNCH INSTRUCTIONS

ITEM	CARD COLUMNS	OPTIONS
CODE	1 2 3 4	
AGE	5 6 7	(Fill in Left Zeros)
PF	8	(1-3)
ET	9	(0-3)
BI	10	(0-1)
SP	11	(0-3)
GR	12 13	(01-12)
SHL	14 15	(11-33)
MF	16	(1-2)
FORM VERSION	17	See Below (D-F)
FORM VERSION	18	(A-C)
QUAD I	19-26	(A-C)
QUAD II	27-34	
QUAD III	35-42	
QUAD IV	43-50	
QUAD V	51-58	
QUAD VI	59-66	

CODES TO BE USED FOR FORM VERSION

D=1

E=2

F=3

CODES TO BE USED FOR QUADRANTS:

C=1

P=2

S=3

D=4

R=5

NR=6

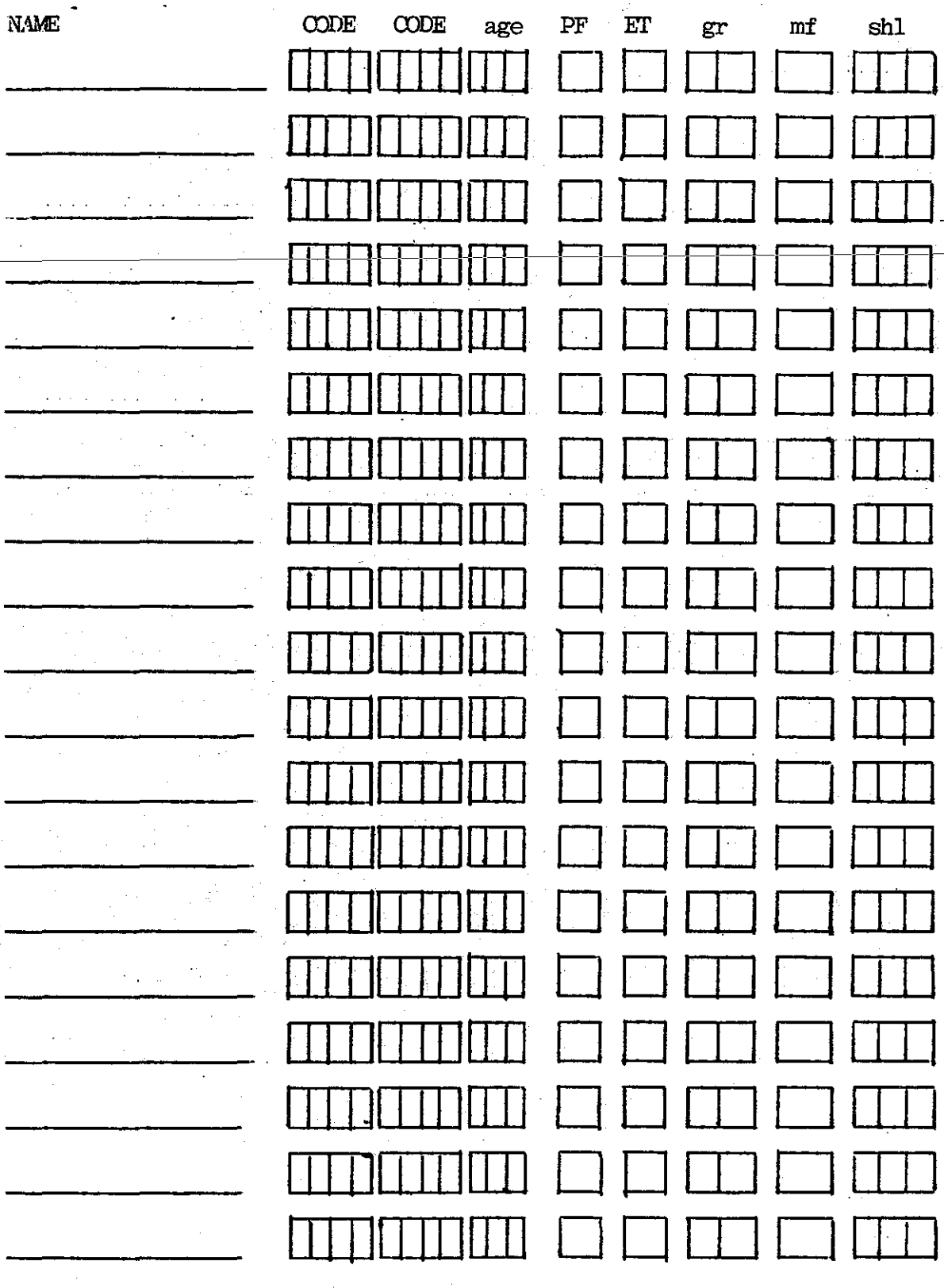
O=7

D&R=8

Multiple Errors=9 (Not D&R)

APPENDIX C

DATA COLLECTION FORM



APPENDIX D

TEST ITEMS

AUDITORY BATTERIES

A	B	C
5	3	8
24	61	19
829	367	574
1932	6953	4258
27586	19374	71468
497318	297465	532186
1982397	5129648	3754861
57291368	13749856	64513748
d	g	l
bs	em	jr
fvo	aid	pkn
zwch	nbex	sfmr
ildah	joupz	ctemn
fakung	bxltdf	jvkndr
ashcxiu	vgexbpt	uatjnlc
rtiskgop	htjmfkpn	dxthorus
*T	*X	*O
OT	ST	TO
SOX	XST	TOS
TXOS	OTSX	SOXT
OTXST	XTXST	TSXOS
SOTXSX	XSOTXT	TXSOTO
TXSTOXT	OTXOSTO	SOTSXOS
STXTOXSO	XOTOSTXS	TSOSXOTX

*SHAPES: S=Square, X=X, O=Circle, T=Triangle

APPENDIX D

TEST ITEMS

VISUAL BATTERIES

D	E	F
9	6	4
21	35	72
685	931	478
5369	2143	7164
82579	38697	21485
643297	518429	318576
4865972	2193418	6231759
75624859	68312479	24851967
e	h	m
ct	fn	ks
gwp	bjh	rlo
axdi	ocfy	tgns
jmebi	kpvra	dufno
gblvoh	cymueg	kwloes
ptidajv	whfacru	ybvkomd
sujtlhpr	ivknglro	eyuipsvt
*S	*X	*O
XO	TS	TX
SXT	XTO	OTS
TOSX	OSXT	XSTO
OSTXS	SXOTX	TXSOX
SXOTXT	XTSOTO	OTXSOS
TOSXOTS	OSXTSOX	XSOXTSX
XTOSOXST	TOSXSTXO	OXSXTSOT

*SHAPES: S=Square, X=X, O=Circle, T=Triangle

APPENDIX E

THE LEARNING PREDICTOR

NAME _____ BIRTHDATE _____ GRADE _____

VISUAL-MOTOR	AUDITORY-MOTOR
1. _____	25. _____
2. _____	26. _____
3. _____	27. _____
4. _____	28. _____
5. _____	29. _____
6. _____	30. _____
7. _____	31. _____
8. _____	32. _____
9. _____	33. _____
10. _____	34. _____
11. _____	35. _____
12. _____	36. _____
13. _____	37. _____
14. _____	38. _____
15. _____	39. _____
16. _____	40. _____
17. _____	41. _____
18. _____	42. _____
19. _____	43. _____
20. _____	44. _____
21. _____	45. _____
22. _____	46. _____
23. _____	47. _____
24. _____	48. _____