PERCEPT AND IMAGINAL REPRESENTATION OF WORDS
AS RELATED TO THE READING PROCESS

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CHAPTER I

THE RESEARCH PROBLEM

Introduction

The processes involved in reading have been the subject of extensive research for many years. Information processing theorists (Gough, 1976; Mackworth, 1971) suggest that sensory input, selective attention, organization of input and retrieval of the processed input are important aspects in the reading process. Processing of sensory input leads to word recognition, reading comprehension and retention of material.

Development of adequate word recognition skills is believed to be an important prerequisite for successful reading comprehension skills by some experts (Smith and Dechant, 1961; Pace and Golinkoff, 1976; Ives, Bursuk and Ives, 1979). These experts suggest that readers use a variety of cues in word recognition skills including whole word cues (i.e., letter position, word shape, word length), phonic cues, semantic clues, syntactic clues, morphemic analysis and orthographic clues.

Estes (1977) proposes that reading skills involve an interaction of perception and memory. Visual patterns such as words must be adequately perceived and processed in order to be recognized when they appear again. Some research suggests that reading disabilities are a function of the interaction of memory and perception processes (Burk and Bruce, 1955; Morrison, Giordani and Nagy, 1977).

According to Gibson and Levin (1975), children demonstrate basic trends in perceptual development that are related to reading. Children develop increased visual discrimination skills which allow them to focus on distinctive features of letters and words. An increasing ability to focus on distinctive features of the stimulus leads to a decreased emphasis on irrelevant aspects. A decrease in the tendency to attend to irrelevant aspects of the graphic information leads to a more efficient processing of it, i.e., extracting smallest distinctive features that will enable the reader to recognize the perceptual units as well as processing the information in the largest units possible for successful completion of the task. More efficient processing of information allows for better organization which, in turn, improves memory of it.

Literature on the development of memory indicates that children acquire an increasing number of mnemonic strategies as they mature and that utilization of such techniques better enable them to remember information (Hagen, Jongeward and Kail, 1975). Visual imagery, a mental process which allows an individual to reconstruct the appearance of perceptual input, has been found to aid in the retrieval of verbal material (Higbee, 1977). A literature review of research on imagery and reading, in which a mental image was thought to "resemble" a picture, suggests that the ability to utilize imagery increases reading comprehension (Jacob, 1976). Jorm (1977) has suggested that imagery facilitates learning of words by way of whole word methods.

Words can be conceptualized according to the height of the lowercase letters that comprise them. Such a whole word method utilizing the configurational cues of ascending and descending letters, is defined by reading specialists as word shape. Research, which focuses on a life span perspective and utilizes height of letters as distinctive features (Weber and McManman, 1977; Weber, Hochhaus and Brown, 1981), indicates that the perceptual system develops prior to the imaginal system, i.e., twenty year olds performed equally well in percept and imagery conditions while nine to eleven year olds performed better when allowed to visually perceive material for which they were making responses. Furthermore, Weber et al.'s (1981) results suggest that information processes are of a general purpose capacity in childhood but become more specialized in young adulthood.

The age level at which children are able to utilize word shape has been a subject of controversy by reading experts. While some research (Arnold, McNinch and Miller, 1978; Fisher and Price, 1970) suggests that beginning readers rely on configurational cues in word recognition skills, there is also experimental evidence (Williams, Blumberg and Williams, 1971; Rayner and Hagelber, 1975; Rayner, 1976) which indicates that children do not utilize configurational cues until they reach the fifth or sixth grade. Smith and Dechant (1966, 1971) suggest that word shape is an effective decoding technique when the reader is already familiar with the word.

With regard to utilization of word shape in word perception skills, two basic questions need to be examined. First, is there a developmental trend in children's ability to process words on the basis of configuration? If, in fact, mature readers are more capable of perceiving a word by its shape than less skilled readers, Gibson and Levin's (1975) distinctive features hypothesis suggests a possible explanation. Second, does the mental process by which word configuration is processed influence a child's ability to retrieve the word? Weber et al.'s (1981) percept-first development hypothesis suggests a theoretical framework from which to investigate these issues.

Statement of the Problem

Perceptual skills and memory skills appear to increase as a child matures. The interaction of memory and perception appears to be related to reading (Burks and Bruce, 1955; Morrison, Giordani and Nagy, 1977). Jorm (1977) suggests that visual imagery, a mental interaction of memory and perception, plays a role in whole word methods of word recognition.

Exploratory research in perceptual and imaginal representation of words (Weber, Hochhaus and Brown, 1981) indicates that twenty year olds demonstrate well-developed visual imagery systems while nine year olds appear to be in the process of developing such information processing strategies. There is limited investigation of the differences in mode of representation between the ages of nine and twenty (Weber and McManman, 1977); further investigation is needed.

If imaginal representation of words influences a child's ability to recall them, then word shape might be considered an important cue in word recognition skills. In addition, if the time for processing words in the percept and imaginal representation is not the same at different age levels, such information could assist reading specialists in determining appropriate word recognition training techniques for different age ranges of children.

Purpose of the Study

The purpose of this study is to examine the influence of perceptual and imaginal representation of words on processing and recall of words between two school aged groups of children. Specifically, this study will examine: 1) The time required to process words in the perceptual and imaginal modes of representation by the two age groups and 2) The role that word shape, as demonstrated by imaginal representation plays in recall of words.

CHAPTER II

REVIEW OF THE LITERATURE

Introduction

The purpose of the present study is to investigate the influence of perceptual and imaginal representation of words on processing and recall tasks between two school aged groups of children. Relevant to this topic, three bodies of literature must be examined: perceptual development, memory and visual imagery. The section on perceptual development focuses on the three major trends in perceptual development related to reading proposed by Gibson and Levin (1975). The section on memory discusses developmental aspects, theoretical issues and procedures for studying memory. The section on visual imagery provides information on important aspects of imagery for retrieval, the relation of imagery to reading skills and the research on perceptual and imaginal representation of letters and words.

Perceptual Development

Gibson and Levin (1975) proposed three major trends in perceptual development that are related to reading. The first trend involves increasing specificity. As children mature they not only see similarities between stimuli but also learn invariant properties of stimuli, i.e., see how stimuli differ from one another. The ability to see invariant properties of stimuli is similar to Gagne's notion of multiple discrimination learning in which the learner acquires a set of individual, sequenced stimulus response connections which allow for greater differentiation among stimuli (Gagne, 1965). The second trend in perceptual development involves optimization of attention. Older children are better able to focus their attention on relevant aspects, i.e., information requested, of the stimulus field. The third trend involves an increasing ability to process information in more efficient ways. With increasing age children demonstrate a better developed ability to organize stimulus information which, in turn, provides better memory of it.

Increasing Specificity

Research tends to support Gibson and Levin's notion of increased specificity in perceptual development. Gibson, Gibson, Pick and Osser (1962) investigated the discrimination of letter like forms with four to eight year old children. The children were required to match standard forms with identical ones. The number of errors made decreased with increasing age. The researchers suggested that the increased performance in discrimination skills resulted from an increased ability to attend to distinctive features. Pick (1965) conducted a series of follow-up experiments with kindergarten and first grade pupils which indicate that training in recognition of distinctive features increases children's ability to make discriminations of letter like forms when they are allowed to view the stimulus item while choosing their response.

Reading specialists have pointed out that when young children begin school, they are able to see similarities in visual stimuli and that the task for the educator is to teach them how the stimuli are different (Smith and Dechant, 1961). Stauffer and Stauffer (1981) suggested that children who reverse letters have a tendency to overgeneralize and think that letters can be moved in any fashion instead of focusing on their invariant properties, e.g., it takes a 180 degree rotation for b to look like d. Miccinati (1981) suggested that children who have difficulty in reading skills do not perceive and analyze distinctive features of words automatically.

Studies of cues used in word recognition skills utilizing a delayed matching-to-sample procedure (Williams, Blumberg and Williams, 1971; Rayner and Hagelberg, 1976; Rayner, 1976) suggest a developmental trend in children's selection of distinctive features. In these experiments subjects were shown three and five letter nonsense words, one at a time, followed by an array of alternative responses. The subjects had to choose the response alternative most like the stimulus item. Kindergarten children demonstrated no consistent pattern in their choices. Young elementary children relied on first letters in word recognition and fifth to sixth grade children demonstrated utilization of word shape in addition to first letters. Adults relied heavily on word shape along with first letters and auditory cues. The findings imply that individuals become better able to analyze words and extract salient features with increasing age and experience.

Experimental evidence suggests that even beginning readers utilize word shape cues. For example, Arnold, McNinch and Miller (1978) conducted a series of experiments with beginning readers who were judged to be average or above average in intelligence and reading readiness. The experimenters investigated the effects of word configuration, ease of pronounceability, type of orthographic structure, level of abstractness of words and utilization of pictures and semantic cues (i.e., noun or verb) on the youngsters' ability to recall words. They found that beginning readers learn nouns, i.e., names of concrete objects, more easily than verbs. More importantly, they also found that beginning readers utilize configurational cues along with initial letters in their word perception skills.

Additional evidence also suggests that configurational cues are utilized more frequently in perception of longer words. Fisher and Price (1970) investigated the use of letter and word shape cues in visual recognition of three and five letter nonsense words, i.e., trigrams and quingrams, with first grade children, third grade youngsters and college students. Their results indicated that first graders relied more heavily on configurational cues than college students. However, configurational cues were used more frequently than letter cues by all subjects with quingrams than trigrams.

In summary, it does appear that children become better able to extract salient features of words with increasing age. There are incompatible research findings regarding the age at which configurational cues become distinctive features in word recognition; some research indicates that configurational cues are not used prior to the age of eleven or twelve while other experimental evidence suggests utilization of word shape cues by six year old children.

Increasing Optimization of Attention

Research also provides some support for Gibson and Levin's notion of increasing optimization of attention with increased perceptual development. Hagen and Sabo (1967) did a cross-modal study of selective attention with children enrolled in the third, fifth, seventh and ninth grades. Youngsters were presented a number of pairs of pictures. Each pair consisted of an animal and a household object. In one experimental condition, the youngsters were instructed to remember the exact pairings, i.e., within pairs. In the second experimental condition the youngsters were instructed to remember the exact order of presentation, i.e., between pairs. The youngsters in the control group were instructed to remember the exact pairings as well as the exact order of presentation. The experimenters found that recall of requested information increased with age and recall of incidental information, i.e., information not instructed to remember, stayed at approximately the same level across all ages.

Research in scanning a visual field for a target item also lends support to the developmental trend of increasing optimization of attention. For example, Katz and Wicklund (1972) investigated the time required by second and sixth grade pupils to visually scan a row of one, two and four letters to determine the presence or absence of a target letter. Sixth grade pupils demonstrated a faster scanning rate and a faster response rate than second graders. No differences were found due to classification of reading ability, i.e., good reader or poor reader.

Research in visual stimulus complexity further lends support to the developmental trend of increasing optimization of attention. Thomas (1966) found that preference for viewing complex random polygons over less complex polygons increased with age in school aged children up to the age of seventeen. The complexity of the polygons varied in number of independent turns in shape, i.e., three to forty independent turns. Chipman and Mendelson (1975) studied the ability of four to ten year old children and adults to choose the simple pattern from pairs of structured-unstructured checkerboard patterns, i.e., symmetrical and asymmetrical patterns, of increasing complexity in shape, i.e., contour. Four to eight year old children could respond to structure in low contour patterns; older children and adults could also respond to structure in high contour patterns. Chipman et al. (1975) suggest that individuals become better able to perceive and organize an increasing number of pattern elements with increasing age. Perhaps, it might be inferred that individuals prefer more complex visual stimuli with an increasing ability to attend to and process relevant aspects.

The ability to attend to relevant information rather than extraneous information, which implies optimization of attention, appears to be a factor which separates good readers and less skilled readers. For example, Santostefano, Rutledge and Randal (1965) found that third to sixth grade boys who had been classified as poor readers had difficulty attending to relevant stimuli in the Fruit Distraction Test. The boys were individually presented a card with colored pictures of fruit against background figures. They were required to read the names of the fruits as quickly as they could. Then they were tested for recall of background figures; the boys labeled as poor readers recalled significantly more irrelevant information than the good readers. The boys were then presented a card of incorrectly colored fruits against background figures. Required to give the correct colors of the fruits as quickly as possible, poor readers took longer to provide the color names and made more errors than good readers suggesting that poor readers also had a semantic retrieval problem.

Belham and Ross (1977) did an experiment of selective attention with first, third and sixth grade boys. The boys were shown twelve displays of six animals paired with six objects. Following the presentation of each display, the stimuli were covered. The boys were then presented a card with an animal on it and asked to point to the location of it in the display. Upon completion of all twelve trials, the boys were shown a display of the six irrelevant objects. Cards with animals on them were presented one at a time and the boys were required to indicate which object went with it. At all grade levels the poor readers performed better on the second task which was purported to measure attention to irrelevant information.

Van de Voort, Lewis, Senf and Benton (1972) studied audiovisual integration in eight to twelve year old retarded and normal readers. The students were presented a stimulus pattern in an auditory or visual mode followed by another stimulus a few seconds later in either the same or alternate mode. The students were required to judge whether the two patterns were the same or different. The retarded readers had difficulty with the task across all modes of presentation. The experimenters suggested that retarded readers have difficulty attending to the relevant aspects of the stimuli.

In summary, it does appear that children are better able to attend to relevant aspects of a stimulus field with increasing age. However, experimental evidence suggests that poor readers lag behind their "normal" peers with respect to this developmental trend.

Increased Efficiency in Processing Information

The studies by Piaget and his associates on cognitive development suggest that there is increased efficiency in processing information with age. The young child centers his attention on a very limited aspect of his perceptual field in problem solving. Elementary school children, approximately seven to eleven years old, demonstrate an ability to consider more aspects of their perceptual field, one at a time, in relation to a possible solution to a given problem. The older child is potentially able to consider all aspects of his perceptual field along with a number of possible solutions in an integrated manner (Wadsworth, 1979).

Gibson (1976) suggested that increased economy of extracting information involves both the detection of the smallest possible distinctive features that will permit a decision as well as the use of higher order structures and rule systems to allow the reader to process information in the largest possible units appropriate for his task. It would seem then that pattern recognition would increase efficiency in processing information. Monroe (1932) found that the inability to perceive a word as a unit rather than letter by letter interfered with reading ability. Kolers (1975) discovered that his sample of seventh grade poor readers demonstrated difficulty analyzing information; they were unable to sort printed sentences into categories of old or new and old in the same form or different form after reading a paragraph.

The ability to handle information in an organized manner appears to increase the efficiency of processing it. Cromer (1970) studied the reading skills of some college students and found that poor readers could perform as well as good readers when the material was presented to them in pre-organized phrases, i.e., short but meaningful word groups.

Oaken, Wiener and Cromer (1971) studied reading comprehension skills of some fifth grade students and found that the performance of poor readers could be improved when the material was read to them. It was suggested that these youngsters utilized poor methods of organizing information when left to their own devices; the auditory input condition organized the material for them.

Torgeson (1977) demonstrated that poor readers of average intelligence in the fourth grade could recall as much as good readers when provided training in the use of mnemonic strategies. Such training could be inferred to teach the youngsters successive cognitive processing strategies which consequently help them organize information for memory.

In conclusion, children's abilities to extract salient features of printed words, attend to relevant aspects of the stimulus field and process incoming visual information in an efficient manner increase with age. Experimental evidence suggests that poor readers have both attentional problems and processing problems. Since processing requires extraction of distinctive features into some meaningful units, it does seem that pattern recognition such as word shape could increase efficiency in reading. There are incompatible research findings on developmental trends in the use of word shape in decoding words.

Memory

Memory plays an important role in learning. The usefulness of learning depends on how well the learner can remember and integrate past information with new experience (Higbee, 1977). The ability to recognize words as well as remember information is a noticeable skill demonstrated by good readers.

Some studies have suggested that reading disabilities are a function of the interaction of perception and memory. Burks and Bruce (1955) analyzed the results of the Wechsler Intelligence Scale for Children which had been administered to children in the third through eighth grades who demonstrated average or above average intelligence. The researchers discovered that the students who were poor readers obtained low scores on the subtests requiring short and/or long term memory. Experimental findings of a study by Morrison, Giordani and Nagy (1977) indicated that good readers in the sixth grade differed from poor readers in their retention of information and not in the quantity or quality of the initial perception.

The way in which material is encoded can affect retention of it. Katz and Wicklund (1973) compared good and poor readers in the fourth and sixth grades on their ability to remember combinations of word-word, picture-word, picture-picture and word-picture. Their results showed that the word-word condition yielded the fastest reaction time for both grade levels. Good readers were quicker in their responses than poor readers implying that there are reading ability differences in the encoding of single words.

Developmental Aspects

From a life span perspective, memory increases from childhood into adulthood and then declines in old age (Reese, 1976). Although all youngsters tend to remember some information without deliberately try-ing to do so, intentional attempts to remember require increasing acquisition of mnemonic strategies (Brown, 1975). Hagen, Jongeward and Kail (1975) pointed out that the ten to eleven year old child demonstrates a repertoire of such strategies which he can utilize according to various situation demands. However, Hagen et al. (1975) stressed that research indicates even young children can use mnemonic strategies to handle a particular task when specifically instructed to do so. These authors believe that such research demonstrates the importance of cognitive processes in memory.

Deliberate attempts to remember information usually requires the individual to encode it in visual or verbal form. Visual imagery processes are involved in visual memory. Processes such as rehearsal, organization and elaboration are involved in verbal or auditory memory. According to Elliot and Carroll (1980), memory development for verbal information proceeds along a continuum from a phase of simple rehearsal to an ability to identify a common element between two items to an attempt to make that common element between two items uniquely meaningful.

Theoretical Aspects

The ability to remember information involves encoding of the sensory input, storing it and being able to retrieve or use it again when needed. Some information is stored in short term or working memory and is available for use only as long as it is being actively processed. Information is also stored in long term or permanent memory and is available for use whenever needed (Vander Zanden, 1980). Because everything an individual knows is represented in his memory (Lachman, Lachman and Butterfield, 1979), it would seem that encoding the more salient features of information to be processed would yield the best retrieval of information.

Lockhart, Craik and Jacoby (1976) suggested that incoming information could be processed at several levels. The greater the depth of analysis of information, the greater the probability of retrieval. The depth of analysis refers to how thoroughly an individual perceives various aspects of the stimulus information, e.g., visual, auditory, contextual, etc.

Paivio (1971, 1976, 1978) stressed visual and verbal aspects of stimulus information in his dual coding theory. He assumed that language is closely related to both speech and imagery. The visual or imaginal mode was described as dealing primarily with spatially organized material while the verbal mode was conceptualized as handling semantic and sequentially organized information. Paivio believed that the two methods of coding were interconnected, i.e., information encoded in visual form could be verbalized and semantic information could evoke images, but could also function independently.

Differences appear to exist between auditory and visual storage in short term memory. Brooks (1967) found that college students could not read a passage describing spatial information and simultaneously visualize it. However, they could visualize the information when the passage was read to them. In another series of experiments, Brooks (1968) found that recall of spatial, i.e., visual, information could be disrupted by concurrent spatial tasks. He concluded that short term memory could handle only a certain amount of information in one modality at a time.

Models of reading based on the information processing approach include Mackworth's model, Rubenstein's model of word recognition and Gough's model (Gibson and Levin, 1975; Gough, 1976; Mackworth, 1971; Rubenstein, Garfield and Millikan, 1970). According to these models, word recognition can begin with visual input of the printed material. The length of visual input is limited by eye fixation and is estimated to last 200-300 msec. in skilled readers. The brief visual stimulus is matched with stored information and leads to a visual image, a reconstruction of the stimulus input. The visual image lasts one to two seconds. The word is coded into short term memory by association of the visual aspects to the corresponding speech sounds. The word must be further coded into long term memory if it is to be recognized again. These models imply that skilled readers develop a large store of information in long term memory and that recognition of words requires a continual comparison of current stimulus input with the individual's internal data base.

LaBerge and Samuels (1974) developed a theory of automatic information processing in reading. They suggested that features such as spelling patterns and word shape provide automatic recognition of words stored in memory. They pointed out that automatic processing of graphemic features is an important factor in fluent reading.

In summary, theories of memory suggest that information is processed at different levels. Sensory input of stimuli from different modalities, e.g., visual and auditory, appear to be related; however, it appears that only a certain amount of information can be handled from one modality at a time in short term memory. Information processing theories of reading suggest that pattern recognition facilitates recognition of words stored in memory.

Recognition and Recall

Recognition and recall are two common procedures for studying memory. Research indicates that both children and adults perform better on recognition tasks than recall. In addition, young children have more difficulty on recall tasks than older children and adults (Developmental Psychology Today, 1971). Recall is generally considered to be a more difficult test of memory as it requires a reconstruction or reproduction of information in the absence of external stimuli; recognition only requires selection of familiar information from a stimulus field of familiar and unfamiliar information.

Factors which influence ease of recognition and recall in reading and word identification include word frequency, similarity and imagery. High frequency words are considered to be easier to recall than low frequency words and low frequency words are easier to recognize (Brown, 1976).

Words similar in construction are more difficult to learn than dissimilar ones. Samuels and Jeffrey (1966) found that kindergarten children had more difficulty learning lists of words constructed with only four different letters than lists of words constructed with eight different letters. Hartley (1970) studied three cues by which kindergarten and first grade children could learn lists of monosyllable words. She found that graphic stimuli, i.e., letters contained in the words, were better cues for children learning lists of minimal contrast words than pictures or contextual cues. Minimal contrast word lists were constructed so that all letters were alike in each word except one.

The ability to construct an image of the information to be remembered has been shown to aid both recognition and recall. Utilization of imagery aids memory by helping individuals focus their attention on important aspects of the information. It is also an efficient way of processing information since one image can relate several concepts (Brown, 1976).

In conclusion, children not only acquire more refined perceptual skills with age but they also appear to acquire increased memory skills with age. Some studies suggest that reading disabilities are a function of the interaction of perception and memory. Information processing theories of reading suggest that the ability to perceive the shape of a word facilitates recognition of it stored in memory. Other factors which influence the ease of recognition and recall of words include word frequency, similarity of word to other words and ability to construct a visual image of the word.

Visual Imagery

There are basically two models of imagery, analogic and propositional. Most research in the area has been based on analogic models which state that a mental image "resembles" a picture (Anderson, 1978; Ross and Kerst, 1978: Kosslyn, 1980). According to this view, images are generated from the memory of actual perceptual units. Ross and Kerst (1978) reviewed the literature on developmental theories of memory and suggested that developmental researchers study the relationship between perceptual and imagery processes with regard to age as a way of looking at how information is organized in memory. The second model of mental imagery, the propositional view, suggests that images are generated from memory by networks of propositions, i.e., rule systems for representing knowledge which are influenced by a person's goals and beliefs versus actual perceptual units (Kosslyn and Pomerantz, 1977; Pylyshyn, 1981).

Visual imagery can be thought of as one of the tools of thought (Hebb, 1968; Piaget and Inhelder, 1971; Yuille and Catchpole, 1977). It is possible to generate images, to inspect one's images (i.e., search one's image to recall and/or check out something) and to transform an image, e.g., change the size, rotate it, etc. (Kosslyn, 1980). Higbee (1976, 1977) has pointed out that visual imagery is used by most mnemonic systems and that research demonstrates it helps in the retrieval of verbal material. Visual imagery aids memory by enabling the individual to reconstruct the appearance of past experiences or inputs in the absence of actual visual stimulation (Neisser, 1967; Bower, 1972).

Research indicates that there is a developmental trend in the ability to make effective use of imagery (Reese, 1970; Rohwer, 1970). Nursery school children can produce images for learning paired associates and youngsters who are eight and older have demonstrated an ability to successfully apply mental imagery techniques to complex tasks, e.g., prose learning (Pressley, 1977b). A study by Ruch and Levin (1979) indicates that even first grade children, i.e., six year olds, can utilize imagery in prose learning if provided partial pictures during learning and again in recall.

Several studies suggest that a relationship exists between the use of visual imagery and stages of cognitive development as defined by Piaget. Hollenberg (1970) studied the relationship between utilization of visual imagery and ability to develop a conceptual understanding of new material with a group of children functioning within the operational stage of cognitive development, i.e., ages six to ten. Her findings indicate that emphasis on utilizing visual imagery interferes with the ability of a child to grasp basic underlying concepts of the material to be learned. Preston (1977) expanded Hollenberg's findings by doing a follow-up study with four groups of students who were considered to be in four phases of cognitive development (Group I: six year olds, acquisition phase of concrete operations, Group II: nine year olds, consolidation period of concrete operations, Group III: eleven year olds, acquisition phase of formal operations, Group IV: fifteen year olds, consolidation phase of formal operations). The students were individually tested on the visual imagery tests used by Hollenberg and three Piagetian tasks (Displacement, Pendulum and Perspectives). Her results indicate that visual imagery can interfere with tasks during acquisition periods of cognitive development but can enhance cognitive functioning during the consolidation periods.

In summary, visual imagery can aid memory of verbal material. Children appear to be better able to effectively utilize imagery with increasing age. In addition, experimental evidence suggests that visual imagery can interfere with task performance during periods in which the child is developing more complex problem solving skills, but it can enhance cognitive functioning during consolidation periods.

Important Aspects of Imagery for Retrieval

Concreteness, meaningfulness and vividness seem to be important aspects of an image if it is to be retrieved. Research indicates that imagery is more highly correlated with recall of semantic material when it is concrete rather than abstract (Paivio, 1971; Pollio, 1974). Johnson (1972) studied the relationship of abstractness versus concreteness in the ability of college students to recall material they read. His results indicated that the more concrete the material, the better the students remembered it. Paivio, Yuille and Madigan (1968) investigated the relationship among concreteness, imagery and meaningfulness for nouns. They found that items rated high in both imagery and concreteness were also rated high in meaningfulness.

Utilization of imagery can make material more meaningful which, in turn, can increase retention of it. In a pilot study with retarded adults, Tomasulo (1980) found that providing imagery instructions which focused on the functional attributes of the stimulus information and also required some kind of interaction with the information to be remembered was an effective training technique. In a study with college students, Allen (1972) instructed one group to utilize absurdity, emotional involvement and motion in their mental imagery to learn some material. He found that students who formed absurd images and interacted with them recalled significantly more than their controls on a Memory for Meaning test.

The keyword mnemonic method, an imagery technique which makes material more meaningful, has been utilized to increase vocabulary learning in children. In this method the subject forms an acoustic link to the stimulus word followed by an imagery link in which the subject imagines the acoustic link, i.e., keyword, interacting with the association. For example, if the vocabulary word were barrister, which means lawyer, the subject might be instructed to form an acoustic link, "bear", followed by a mental image of "a bear acting like a lawyer."

Taylor (1980) demonstrated acquisition and memory recall of vocabulary words by thirteen year old boys who had been diagnosed as Learning Disabled utilizing the keyword mnemonic method. Pressley (1977a) demonstrated that it was possible to help second and fifth grade children learn more Spanish vocabulary words via this method than their peers who were not instructed in this manner.

Vividness of an image has been found to be related to recall, i.e., the more vivid the image, the greater the recall (Higbee, 1979). Radaker (1959) found that fourth grade pupils who received practice in making clear, bold images of low frequency words were able to improve their memory for the words.

There are individual differences in the vividness of imagery as demonstrated by Galton's breakfast table test in the 1800s (Segal, 1971). Galton found that children, housewives and common laborers could recall their breakfast tables more vividly than more educated men. McKelvie and Demers (1979) compared two groups of high school students (low visualizers and high visualizers as measured by the Vividness of Visual Imagery Questionnaire) on memory tasks. They found that high visualizers were superior to low visualizers in short term recall of abstract words, concrete words and pictures. In long term recall, high visualizers were superior to low visualizers only on the concrete words and pictures.

In summary, concreteness and meaningfulness of material and vividness of the image are positively related to retrieval. Techniques which increase meaningfulness, e.g., absurdity and the keyword mnemonic method, have been found to increase recall of material to be learned. Individual differences have been found in the vividness with which people report imaging.

Imagery as Related to Reading Skills

Jacob (1976) reviewed the literature on the analogue model of mental imagery and reading comprehension and concluded that good readers are able to utilize visual imagery. He felt that such an ability enhanced their comprehension. Levin and Devine-Hawkins (1974) studied the effects of visual imagery in prose learning with fourth and fifth grade students and found that imagery instructions yielded greater recall under listening than reading conditions. Such findings are consistent with Brooks' experiments (1967, 1968) on modality limitations for storage and retrieval in short term memory.

Cramer (1980) investigated the relationships among reading attitude, reading comprehension and mental imagery with eleventh and twelfth grade students by analyzing their scores on the Estes Reading Attitude Scale, the Davis Reading Test (Series 2) and the Questionnaire on Mental Imagery. He found significant correlations between reading attitude and mental imagery and between reading comprehension and reading attitude. Cramer's results showed no significant relationship between reading comprehension and mental imagery.

Research indicates that high imagery words, i.e., words which evoke mental pictures of objects or actions, are easier for beginning readers to learn than more abstract, low imagery words (Van der Veur, 1975; Kolker and Terwilliger, 1981). Jorm (1977) did a series of studies investigating the relationships between level of imagery of words, reading performance and reading ability with school aged children. He found that poor readers could handle high imagery words with greater ease than low imagery ones. In addition, the results indicated that imagery facilitated learning to read in both good readers and poor readers when forced to read via whole word methods, i.e., read letter like forms which had no phonological counterparts.

In summary, research on imagery and reading, in which an image was thought to "resemble" a picture, suggests that the ability to utilize imagery increases reading comprehension. There is also some experimental evidence which suggests that imagery facilitates learning of words by way of whole word methods, e.g., shape of the word.

Perceptual and Imaginal Representation of Letters and Words

Experimental investigation of perceptual and imaginal representation of letters and words also emerges from the analogue model of imagery. Research indicates that it takes longer to imagine letters and respond according to directions than it does to directly perceive them (Weber and Castleman, 1970). Weber and Harnish (1974) investigated the time required to process high frequency three and five letter words in percept and imagery conditions. Subjects were required to identify target letters of words by height of letter (tall lowercase letters = yes, short lowercase letters = no). The researchers found that it took more time for subjects to process an image than a percept on five letter words. The longer time required for response appeared to be due to a need for sequentially ordering the material to generate images versus simply having to scan the letters.

Weber, Kelley and Little (1972) looked into the possibility that sequencing of letters under imaginal conditions might be under verbal control. In a series of experiments these investigators had separate groups of subjects imagine alphabet strings and high frequency four letter words. The results indicated that subjects use verbal control for sequencing of alphabet strings but not for the short words. Weber et al. (1972) concluded that the visual imagery system can only hold a limited number of simultaneously presented letters and when that capacity is taxed, verbal sequential control plays an important role.

Research suggests that there are individual differences in the ability to utilize imagery. McCoy and Weber (1981) studied the imaginal and perceptual representation of words in normal and Learning Disabled nine year old children. The subjects were familiarized with the words to be used and trained to classify lowercase letters according to height. Then they were required to classify target letters (first or last letters) of each word in six sentences. The sentences were presented in three conditions: visually, auditorily and mixed. In the visual or percept condition the students were allowed to look at the sentence while responding. In the auditory or image condition the sentence was read to the student and he had to imagine the letters in order to respond. In the mixed or control condition the sentences were printed in uppercase type and had to be mentally transformed to lowercase in order to handle the task. The results demonstrated that it took the students longer to process imagined letters and provide a response than it did to directly perceive them. The results also indicated that normal children have a greater image capacity than Learning Disabled children.

Experimental evidence also suggests that there are developmental changes in perceptual and imaginal representation. Weber and McManman (1977) studied the visual representation of first grade words in perceptual and image modes with normal children between the ages of nine to eleven and college students. Their results indicate that perceptual representation matures prior to image representation. Weber, Hochhaus and Brown (1981) did a follow-up, exploratory study utilizing three groups of subjects (nine year olds, twenty year olds and sixty-eight year olds). Subjects were given tasks in which they identified lowercase letters in sentences according to height, i.e., short or tall, and classified corners of block letters according to directions. The nine year olds and sixty-eight year olds performed better when allowed to visually perceive the material while responding. The twenty year olds did about equally well in the percept and imagery conditions. The results indicate that the perceptual system develops prior to the imagery system and that the imagery system declines first. The results imply that the perceptual system is a general processing system while the imaginal system is more specific.

In conclusion, not only do children appear to be better able to effectively utilize visual imagery with increasing age, there also appears to be a similar trend in the development of the imagery system. In addition, experimental evidence suggests that visual imagery can interfere with task performance during periods in which the child is developing more complex problem solving skills, but it can enhance cognitive functioning during consolidation periods.

Relationship of the Literature to the Present Study

Gibson and Levin (1975) proposed that perception is a basic aspect in reading and that increasing development of the perceptual system allows for greater efficiency in processing information. LaBerge and Samuels (1974) have suggested that utilization of pattern recognition, e.g., word shape, provides the greatest efficiency in processing printed words. Greater efficiency in processing information implies a better developed ability to encode and store the material in memory. Developmental research indicates that individuals become increasingly more adept at utilizing mnemonic techniques from childhood into young adulthood (Reese, 1976; Hagen, Jongeward and Kail, 1975). Research also indicates that visual imagery can facilitate memory of verbal material (Higbee, 1977) and that there is a developmental trend in the ability to effectively utilize imagery (Reese, 1970; Rohwer, 1970). In addition, Jorm (1977) suggests that visual imagery, a mental interaction of memory and perception, facilitates learning to read in both good and poor readers by way of whole word methods of recognition, e.g., word shape.

Since perception, memory and imagery appear to play a role in information processing, there appears to be a need to explore the relationship among them with regard to age. Exploratory work by Weber, Hochhaus and Brown (1981) on perceptual and imaginal representation of words, in which the words were conceptualized according to height of letters comprising them, i.e., word shape, indicates that the percept system develops prior to the imaginal system. The present study will investigate how the two modes of representation affect processing of words and influence recall of the words at two age levels.

If imaginal representation of words influences a child's ability to recall them, then word shape might be considered an important cue in word recognition skills. In addition, if the time for processing words in the imaginal representation is not the same at different age levels, a developmental trend in ability to process words on the basis of pattern recognition may emerge.

Definition of Terms

For the purpose of this investigation, the following terms and definitions will be employed:

Graphic stimuli - printed or written symbols, e.g., letters comprising a word.

Imaginal representation - imaging or recalling visual information in the absence of external cues.

Pattern recognition - ability to identify a word on the basis of distinctive features which give it a unique form, e.g., word shape.

Perceptual representation - perceiving visual or spatial information directly, i.e., in the presence of external visual cues.

Processing - time from onset of stimulus presentation to completion of response.

Visual image - representation of spatial information from memory, i.e., in the absence of external visual or perceptual representation.

Word recognition - ability to remember a familiar word upon sight.

Word shape - the outline or configuration of an entire word based on the height of lowercase letters, i.e., ascending and descending.

Assumptions Underlying the Study

The assumptions underlying this study are as follows:

1. Word shape, conceptualized in terms of height of lowercase letters comprising the word, can be processed as a visual image.

2. Students participating in the study will not have prior knowledge of the content of the word lists nor experimental conditions to be presented.

3. Students will follow instructions and try to do the best they can.

Research Questions

In relation to the purpose of the present study, three major research questions and two minor research questions are formulated. The first question focuses on differences in processing word configuration in percept and imaginal modes on the basis of age. Since research indicates that visual imagery facilitates learning to read by whole word methods regardless of reading ability, the second question deals with differences in processing word configuration in the percept and imaginal modes on the basis of reading ability. The third question focuses on differences in retrieval of words processed as a result of the mode of representation. Since it has been suggested that word shape facilitates word recognition only when the word is already known, a minor and fourth research question focuses on differences in processing high frequency words and pseudowords in percept and imaginal modes. In addition, since the ability to process words by height of letter implies the ability to spell them, the last research question looks at the number of words spelled correctly as a function of the mode of representation.

Research Question One: Does the time for correctly processing words in perceptual and imaginal modes vary with age level?

Research Question Two: Does the time for correctly processing words in percept and imaginal modes vary with reading ability, i.e., average and above versus below average ability?

Research Question Three: Are the number of words correctly recalled related to the mode of representation used in processing the words?

Research Question Four: Does the time for correctly processing words in perceptual and imaginal modes vary with type of word, i.e., high frequency words versus pseudowords?

Research Question Five: Are the number of words spelled correctly related to the mode of representation used in processing the words?

Hypotheses

The following null hypotheses are formulated in conjunction with the preceding research questions:

Hypothesis One: There will be no difference in time for processing words correctly in percept and imaginal modes with different age levels.

Hypothesis Two: There will be no difference in time for processing words correctly in percept and imaginal modes with regard to reading ability, i.e., high versus low.

Hypothesis Three: There will be no difference in the number of words correctly recalled as a function of mode of representation.

Hypothesis Four: There will be no difference in time for processing words correctly in percept and imaginal modes as a function of type of word, i.e., high frequency word versus pseudoword.

Hypothesis Five: There will be no difference in the number of words spelled correctly as a function of mode of representation.

CHAPTER III

METHODOLOGY

Subjects

The subjects were 48 third grade students (age range of eight years, three months to nine years, eleven months) with a mean age of nine years, zero months and 48 eighth grade students (age range of thirteen years, one month to fifteen years, three months) with a mean age of fourteen years, zero months. The 96 subjects were randomly selected from 143 volunteers enrolled in the Inola and Union public school districts in order to construct a balanced design. Seventeen additional subjects were discarded due to tape recorder failure and inability of the subjects to comply completely with task demands. Subjects were randomly assigned to each of the three different experimental conditions for mode of representation.

Half of the subjects in each grade level came from each school district. The Inola school district serves a rural community in northeastern Oklahoma and had a school population of 890 during the 1981-82 school year. The parents of Inola school children are primarily blue collar workers. The Union school district serves part of southeast, suburban Tulsa county and had a school population of 6766 during the 1981-82 school year. The parents of Union school children are primarily white collar workers and professional people. During the 1981-82 school year Inola elementary students were using the Houghton Mifflin Company reading series which emphasizes a language experience approach to reading and Union elementary students were using the Lippincott reading series which emphasizes a phonetic approach.

The subjects at each grade level were divided into high ability and low ability readers on the basis of the percentile rank they obtained in total reading on the second edition of the Gates-MacGinitie Reading Tests, a norm referenced measure of reading ability, administered in April, 1982. The 55th percentile rank was chosen to divide subjects into ability groups (55 and up = high, below 55 = low) in order to construct a balanced design. Level C, Form 2 of the Gates-MacGinitie was administered by school personnel to all third graders and Level E, Form 3 was administered to all eighth graders. Third grade subjects obtained percentile ranks ranging from 3 to 99; the range for eighth grade subjects was 5 to 99.

The third grade subjects consisted of 18 females and 30 males; eighteen of the students were involved in remedial reading and/or learning disabilities classes. The eighth grade subjects consisted of 22 females and 26 males; ten of the students were involved in remedial reading and/or learning disabilities classes. All subjects were free of known neurological impairment and uncorrected visual or auditory problems. The sample consisted primarily of Caucasian students (92.7% Caucasian, 4.2% American Indian, 3.1% Black). There were no Blacks represented in the eighth grade subjects.

Written parental consent to participate in the study was obtained on all subjects. The permission form appears in Appendix A. To insure anonymity each subject was given a blind code which identified his school district, experimental condition, age group and subject number.

Materials and Equipment

Materials

The materials consisted of three demonstration cards, an alphabet card, four sets of stimulus word cards, three response record sheets and a set of instructions. Each of the demonstration cards were 4 x 6 inch unruled index cards upon which were printed sample letters for a given letter height, i.e., up, down, flat. The sequence in which the letters appeared on each card is shown in Appendix B. All letters were printed in lowercase form with a black felt tip pen. Ascending (up) and descending (down) letters measured 1.5 cm. in height; the remaining letters (flat) measured 1 cm. in height.

The alphabet card was a 5 x 8 inch unruled index card upon which the 26 letters of the alphabet appeared in a random sequence. All letters were printed in lowercase form to the same dimensions described above. The sequence in which the letters appeared is shown in Appendix B.

The four sets of stimulus word cards consisted of two word lists printed in two forms, i.e., high frequency words and pseudowords, printed in lowercase and capital letters. Each word was printed on a 4 x 6 inch unruled index card. Capital letters measured 1.5 cm. in height.

All stimulus words were four letter monosyllables. There were three example words and nine test words in each list. The high frequency words were selected from the Harris-Jacobson list of core words for first grade (Harris and Jacobson, 1973). The pseudowords were formed by substituting a letter of the same height for the first letter in each high frequency word. The words were counterbalanced with regard to height of letter in first and last letter positions and consonant-vowel-consonant phoneme (CVC) patterns (Appendix B).

The three response record sheets used for each subject appear in Appendix B. The first two record sheets provided the investigator a standard form upon which to record subjects' responses for processing and recalling high frequency stimulus words and pseudowords, i.e., List I and List II, respectively. The numerical order, i.e., 1 to 9, in which the words were presented to each subject were recorded to the left of each word on each list. The third response sheet provided subjects a standard form upon which to write stimulus words from dictation; this sheet was folded in half so that only one list of response blanks was presented to the subject at a time.

The instructions used in the experimental sessions appear in Appendix C. All subjects received the same Training Instructions for height of letter as well as the same Concluding Comments. The Training Instructions were followed by specific instructions for the experimental condition, i.e., mode of processing, to which subjects had been assigned.

Equipment

The equipment used in collecting data during the experimental sessions consisted of a 7 jewel Northstar stopwatch and a Sony TC-72 cassette tape recorder.

Procedure

Experimental sessions were conducted on school premises during school hours and averaged 20 minutes per child. Each child was worked with individually and seen for only one session. Each experimental session was tape recorded to accurately and reliably check response time measures; any discrepancy between experimental session timing and the reliability check timing was averaged (There was a discrepancy of one second on 26.9% of the responses; approximately half of these discrepancies were due to one more second on reliability timing than experimental session timing and half were due to one second less.). The data was collected between the months of February and May, 1982.

In each experimental session, the subject was given training for classification of lowercase letters by height of letter. Then the subject engaged in a series of activities for the two word lists. The activities involved reading the words, processing them according to height of letter, recalling the words and spelling them from dictation. Each word list began with three example words; subjects did not write example words from dictation. Upon completion of activities for example words, the subject proceeded to activities for the test words. Upon completion of activities for List I words, subjects were administered the same activities for List II words. List I was always given first. The experimental sessions differed only in mode of representation, i.e., percept, imaginal or mixed, subjects were instructed to use for processing the words. Upon completion of the experimental session, each subject was thanked for his participation and given instructions for what he could say about the session to others.

Letter Classification Training

Upon entering the experimental situation, the subjects were given training instructions for classification of lowercase letters by height of letter. They were shown an index card with lowercase letters printed in random sequence and instructed to classify the letters by height, i.e., up, down or flat. Ascending letters such as d, f and t were called "up" letters. Descending letters such as g, j and p were called "down" letters. The remaining letters such as a, c and m were called "flat" letters. Errors in classification were corrected and misclassified letters were reviewed.

Reading of Words

Subjects were familiarized with the stimulus words used in each set of activities, e.g., List I examples, by having them read the words from index cards. Each word list was presented to subjects in random order; the index cards were shuffled prior to each experimental session. Subjects in the percept and image conditions read cards upon which words were printed in lowercase letters; subjects in the mixed condition read the words printed in capital letters. Errors were corrected and mispronounced words were reviewed. Subjects were allowed up to three trials to read mispronounced words correctly.

Processing of Words

There were three between subjects experimental conditions, i.e., modes of representation for processing words by height of letter, to which subjects were randomly assigned prior to entering the experimental situation. These modes of representation were percept, imaginal and mixed. In the percept condition subjects viewed index cards upon which words were printed in lowercase letters while processing them for configuration. In the imagery condition subjects were orally presented each word and had to imagine it printed in lowercase letters in order to comply with task demands. In the mixed condition subjects viewed index cards upon which words were printed in capital letters; these subjects had to mentally transform letters to their lowercase counterparts in order to comply with task demands. The mixed condition was implemented to serve as a control group for the percept and image groups. Response time was measured to the nearest second on each word. A stopwatch was started at the onset of the presentation of each stimulus word and was stopped when the subject completed his response.

Words were presented for processing in the same order in which they had been read. Letters in each word were processed in forward sequence only, i.e., left to right. All mistakes made on example words and the first two mistakes made by a subject on List I were recorded and corrected; accuracy was encouraged. Additional mistakes were simply recorded on response sheets.

<u>Recall of Words</u>

Upon completion of processing a given set of words, subjects were instructed to say as many of the words as they could remember. This was a free recall task, i.e., subjects could say words in any order; however, they were given a two minute time limit for recall of test word lists. The number of words correctly recalled was maintained for each subject.

Spelling of Words

Upon completion of recall for test words in each test, subjects were administered a spelling test over the words. The investigator dictated the words in alphabetical order and the subjects wrote them on the response sheet provided. Each word was dictated only once. The number of words correctly spelled was tallied for each subject.

Design

The design consisted of a factorial arrangement of two ages (nine year olds and fourteen year olds) by two reading ability levels (high and low) by two modes of representation (percept, imaginal and mixed) by two word lists (high frequency words and pseudowords). Age, reading ability level and mode of representation were between subject variables while type of word list was a within subject variable. The response measures included time to process words by height of letter, number of words correctly recalled and number of words spelled correctly.

CHAPTER IV

RESULTS

Introduction

The purpose of this chapter is to present the results of the statistical analysis of data for the five research questions formulated in the present study. The emphasis of the study is to examine the effects of perceptual and imaginal representation of words in two age groups of school children representing both high and low reading ability on three dependent measures: response time, recall and spelling.

The split-plot factorial (SPF-pru.q) research design (Kirk, 1968) was employed to investigate the research questions. Separate split-plot analyses with repeated measures on the last factor, i.e., word type, were conducted for each of the three dependent measures.

Response Time

Since subjects did not process all words correctly, response time for words correctly processed was analyzed separately from response time for errors. A summary of the analysis of variance in which response time for correct responses is the dependent variable is presented in Table I. The dependent variable of time for correct responses is defined as the mean time for unprompted responses. As can be seen from this table, three main effects, Ability (A), Age (C) and Mode of

Representation (D) are significant. Three two-way interactions, Ability by Age (AC), Age by Mode (CD) and Word Type by Mode (BD) and one three-way interaction, Ability by Word Type by Mode (ABD) are also significant.

TABLE I

SUMMARY TABLE FOR THE ANALYSIS OF VARIANCE FOR THE DEPENDENT VARIABLE OF CORRECT RESPONSE TIME

Source	SS	df	MS	F	p
Between Subjects	864.2429	95			
A (Ability)	61.1444	1	61.144	23.58	.0001
C (Age)	245.5944	1	245.594	94.72	.0001
D (Mode)	275.6029	2	137.801	53.15	.0001
A x C	19.1079	1	19.108	7.37	.0080
A x D	.4132	2	.207	.08	
C x D	40.6151	2	20.308	7.83	.0008
A x C x D	3.9754	2	1.988	.77	
Subj. w. Groups	217.7896	84	2.593		
Within Subjects	58.2036	96			
B (Word Type)	1.9020	1	1.902	3.69	
A x B	.1155	1	.116	.22	
B x C	.2860	1	.286	.56	
B x D	4.5895	2	2.295	4.45	.0145
A x B x C	.2783	1	.278	.54	
A x B x D	4.7716	2	2.386	4.63	.0124
B x C x D	1.7618	2	.881	1.71	
A x C x D	1.2217	2	.611	1.19	
B x Subj. w. Groups	43.2772	84	.515		
Total	922.4465	191			

Hartley's F_{max} test (Kirk, 1968) for testing the assumption of homogeneity of error variance for the two error terms (Subj. w. Groups and B x Subj. w. Groups) is significant, $F = 5.03$, $p < .05$, indicating that error variances are heterogeneous. Since the error variances are not homogeneous, they cannot be pooled when testing for simple effects of interactions involving the repeated measure, word type. The larger MS_{error}, Subj. w. Groups, is used in these follow-up analyses to determine if significant differences exist in order to guard against making Type I errors.

Research Questions One, Two and Four deal with correct response time. Research Question One focuses on the Age by Mode (CD) interaction; Research Question Two focuses on the Ability by Mode (AD) interaction. Research Question Four focuses on the Word Type by Mode (BD) interaction. In addition to reporting results pertinent to these questions, this section will also review the Ability by Age (AC) interaction, provide strength of association values for significant main effects and interactions and examine response time for incorrectly processed responses.

Research Question One

Research Question One asks: Does the time for correctly processing words in percept and imaginal modes vary with age level? The significant Age by Mode (CD) interaction indicates that the time for processing words by mode does vary with age level. Therefore, the corresponding null Hypothesis I stating that there will be no differences in processing words in percept and imaginal modes with different age levels is rejected for the present study.

The simple effects breakdown for the Age by Mode interaction (Table II) indicates that all five simple effects contribute significantly to this interaction. Comparison of means of the two age levels for each mode (C at d_o) indicates that nine year olds took longer to process words than fourteen year olds in each mode of representation (Table III). Tukey's HSD post hoc comparisons of means (Kirk, 1968) for Mode by Age level (D at c_k) shows that nine year olds took longer to process words in the imaginal mode than in mixed or percept modes (Table III). In addition, nine year olds took longer to process words in the mixed mode than the percept mode. Fourteen year olds took more time to process words in the imaginal mode than percept mode; no other differences were found.

TABLE II

SIMPLE EFFECTS BREAKDOWN FOR THE AGE (C) BY MODE OF REPRESENTATION (D) INTERACTION FOR THE DEPENDENT VARIABLE OF CORRECT RESPONSE TIME

Source	SS	df	MS	F
C at d_1	22.22	1	22.22	8.579**
C at d_2	187.92	1	187.92	72.556**
C at d_3	76.06	1	76.06	29.367**
D at c_1	263.79	2	131.90	50.927**
D at c_2	52.43	2	26.22	10.124**
Subj. w. Groups	217.79	84	2.49	

** $p < .01$

TABLE III

MEAN CORRECT RESPONSE TIME AND TUKEY'S HSD POST HOC COMPARISONS FOR THE MAIN EFFECTS OF MODE OF REPRESENTATION BY AGE LEVEL

	Image	Mixed	Percept
9 year olds	8.10	5.97	4.04
Image		2.13**	4.06**
Mixed			1.93**
Percept			
14 year olds	4.67	3.79	2.86
Image		.88	1.81**
Mixed			.93
Percept			

* $p < .05$
** $p < .01$
Critical Differences: .05 = .97
.01 = 1.22

Differences in number of words processed by mode at each age level are shown in Table IV and Figure 1. While both age levels correctly processed approximately the same number of words in the percept mode on both lists, older students processed approximately one more word correctly per list than nine year olds in the imaginal mode.

TABLE IV

DESCRIPTIVE STATISTICS FOR THE NUMBER OF WORDS CORRECTLY PROCESSED AND TIME FOR PROCESSING BY AGE, WORD TYPE AND MODE OF REPRESENTATION

	% words correctly processed	$\bar{X}$	SD	$\bar{X}$ time (sec.)	SD (sec.)
9 year olds (n = 16)					
High Frequency Words (n = 9)					
Percept	98.61	8.88	.33	4.39	1.79
Mixed	86.11	7.75	1.64	6.14	1.28
Image	83.33	7.50	1.58	7.98	2.39
Pseudowords (n = 9)					
Percept	98.61	8.88	.33	3.68	.63
Mixed	90.97	8.19	1.18	5.79	1.13
Image	78.47	7.06	1.85	8.21	2.67
14 year olds (n = 16)					
High Frequency Words (n = 9)					
Percept	97.92	8.81	.39	2.87	.90
Mixed	84.72	7.63	2.03	4.07	.96
Image	98.61	8.88	.33	4.55	.45
Pseudowords (n = 9)					
Percept	97.92	8.81	.51	2.85	1.02
Mixed	91.67	8.25	.83	3.50	.70
Image	90.28	8.13	.92	4.79	.79

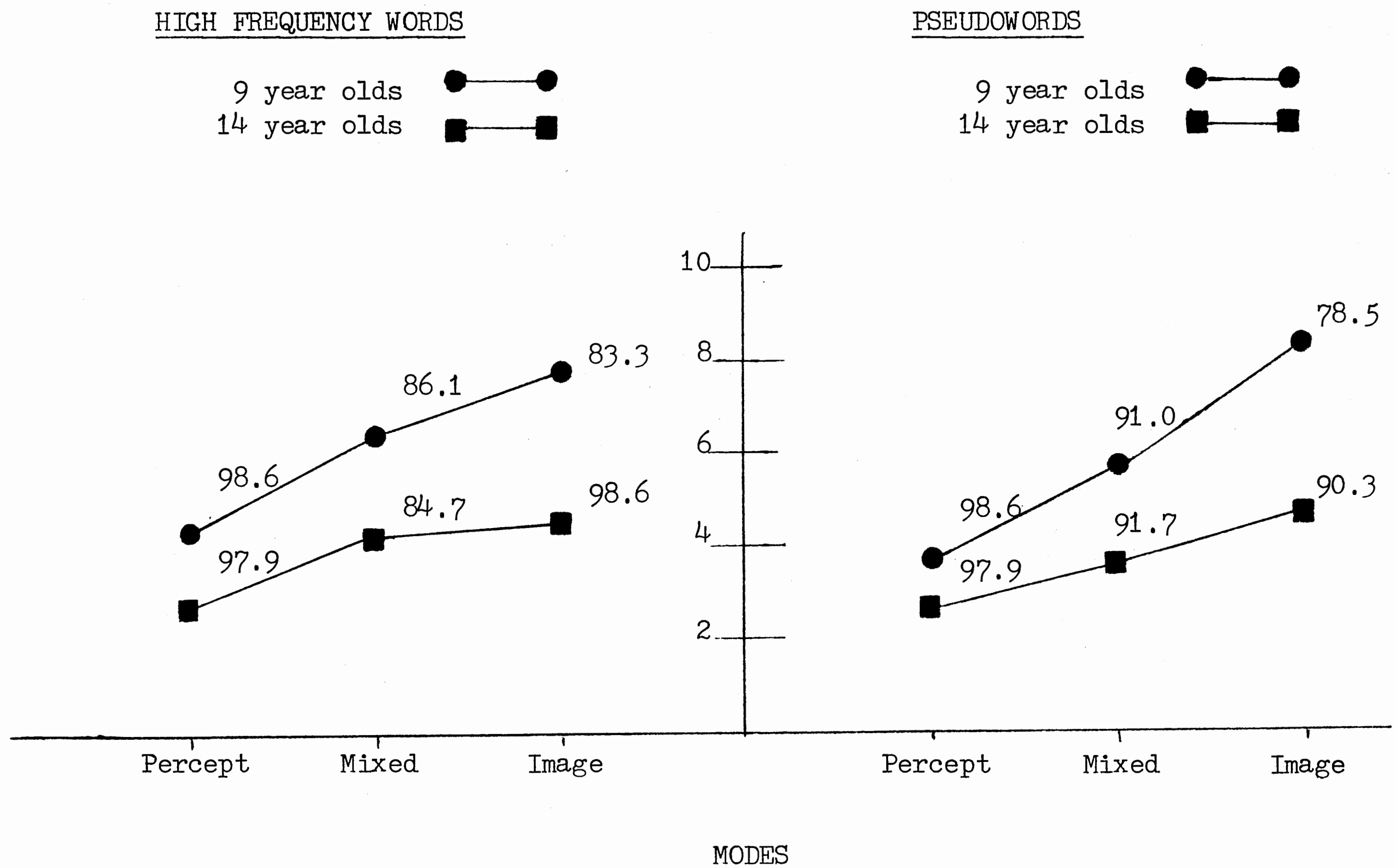

Figure 1. Mean Time (sec.) and Percentage of Words Correctly Processed for the Age by Mode (CD) Interaction

Research Question Two

Research Question Two asks: Does the time for correctly processing words in percept and imaginal modes vary with reading ability levels? The lack of a significant Ability by Mode interaction indicates that the time for processing words by mode does not vary with reading ability level. Therefore, the corresponding null Hypothesis II stating that there will be no difference in time for processing words in percept and imaginal modes with regard to reading ability cannot be rejected.

Although the Ability by Mode interaction is not significant, a three-way interaction which includes these two factors is significant, i.e., the Ability by Word Type by Mode interaction. The breakdown of simple effects (Table V) indicates that ability contributes significantly to differences in response time at combinations of word type and mode (A at bd_{jo}) and that mode contributes significantly to differences at combinations of ability and word type (D at ab_{ij}).

Cell means (Table VI) were compared for each significant simple effect of ability at each combination of word type and mode (A at bd_{jo}). Comparison of the cell means for the simple effect of ability at the combination of high frequency words by percept and mixed modes, respectively (A at bd_{11} and A at bd_{13}), indicates that low ability students took more time to process high frequency words in both modes than high ability students. Comparison of cell means for the simple effect of ability at the combination of pseudoword list and imaginal mode (A at bd_{22}) shows that low ability students also took longer to process pseudowords in the imaginal mode than high ability students.

TABLE V

SIMPLE EFFECTS BREAKDOWN FOR THE ABILITY (A) BY WORD TYPE (B) BY MODE OF REPRESENTATION (D) INTERACTION FOR THE DEPENDENT VARIABLE OF CORRECT RESPONSE TIME

Source	SS	df	MS	F
A at bd_{11}	13.70	1	13.70	5.290*
A at bd_{12}	4.81	1	4.81	1.857
A at bd_{13}	10.63	1	10.63	4.104*
A at bd_{21}	4.86	1	4.86	1.876
A at bd_{22}	24.17	1	24.17	9.332**
A at bd_{23}	8.25	1	8.25	3.185
B at ad_{11}	.09	1	.09	.035
B at ad_{12}	.48	1	.48	.185
B at ad_{13}	1.25	1	1.25	.482
B at ad_{21}	3.19	1	3.19	1.230
B at ad_{22}	4.08	1	4.08	1.573
B at ad_{23}	2.27	1	2.27	.875
D at ab_{11}	67.34	2	33.67	13.000**
D at ab_{12}	60.92	2	30.46	11.761**
D at ab_{21}	45.32	2	22.66	8.749**
D at ab_{22}	111.79	2	55.90	21.583**
Subj. w. Groups	217.79	84	2.59	

* $p < .05$
** $p < .01$

TABLE VI

MEAN CORRECT RESPONSE TIME FOR THE ABILITY (A) BY WORD TYPE (B) BY MODE OF REPRESENTATION (D) INTERACTION

	High Frequency Words	Pseudowords
Percept		
High ability	2.98	2.88
Low ability	4.29	3.66
Image		
High ability	5.88	5.63
Low ability	6.66	7.37
Mixed		
High ability	4.53	4.14
Low ability	5.69	5.15

Tukey's HSD post hoc comparisons were performed for each of the significant simple effects of mode at combinations of ability and word type (D at ab_{ij}). Tukey's comparisons of means for mode of representation in high frequency words by ability indicates that high ability students took longer to process high frequency words in the imaginal mode than in the mixed or percept modes (Table VII) while low ability students took longer to process words in the imaginal mode than the percept mode. Both ability levels took longer to process high frequency words in the mixed mode than the percept mode.

TABLE VII

MEAN CORRECT RESPONSE TIME AND TUKEY'S HSD POST HOC COMPARISONS FOR THE MAIN EFFECTS OF MODE OF REPRESENTATION IN HIGH FREQUENCY WORDS BY ABILITY

	Image	Mixed	Percept
High Ability	5.88	4.53	2.98
Image		1.35*	2.90**
Mixed			1.55**
Percept			
Low Ability	6.66	5.69	4.29
Image		.97	2.37**
Mixed			1.40**
Percept			

* $p < .05$
** $p < .01$
Critical Differences: .05 = 1.37
.01 = 1.72

Tukey's HSD post hoc comparisons of means for the mode of representation in pseudowords by ability indicates that both high and low ability students took longer to process pseudowords in the imaginal mode than the mixed or percept modes (Table VIII). In addition, low ability students took longer to process words in the mixed mode than the percept mode.

TABLE VIII

MEAN CORRECT RESPONSE TIME AND TUKEY'S HSD POST HOC COMPARISONS FOR THE MAIN EFFECTS OF MODE OF REPRESENTATION IN PSEUDOWORDS BY ABILITY

	Image	Mixed	Percept
High Ability	5.63	4.14	2.88
Image		1.49*	2.75**
Mixed			1.26
Percept			
Low Ability	7.37	5.15	3.66
Image		2.22**	3.71**
Mixed			1.49*
Percept			

* $p < .05$
** $p < .01$
Critical Differences: .05 = 1.37
.01 = 1.72

Research Question Four

Research Question Four asks: Does the time for correctly processing words in percept and imaginal modes vary with type of word, i.e., high frequency words versus pseudowords? The significant Word Type by

Mode interaction suggests that time for correctly processing words by mode does vary with word type. Therefore, the corresponding null Hypothesis IV stating that there will be no difference in time for processing words in percept and imaginal modes with regard to type of word is rejected for the present study.

The analysis of simple effects (Table IX) indicates that the significant differences arise from mode of representation at each word type (D at b_j). Tukey's HSD post hoc comparisons of means for mode by word type (Table X) shows that it took longer to process both types of words in the imaginal mode than in mixed or percept modes. In addition, it took longer to process both types of words in the mixed mode than in the percept mode.

TABLE IX

SIMPLE EFFECTS BREAKDOWN FOR WORD TYPE (B) BY MODE OF REPRESENTATION (D) INTERACTION FOR THE DEPENDENT VARIABLE OF CORRECT RESPONSE TIME

Source	SS	df	MS	F
B at d_1	2.16	1	2.16	.834
B at d_2	.88	1	.88	.340
B at d_3	3.45	1	3.45	1.332
D at b_1	111.48	2	55.74	21.521**
D at b_2	168.72	2	84.36	32.571**
Subj. w. Groups	217.79	84	2.59	

** $p < .01$

TABLE X

MEAN CORRECT RESPONSE TIME AND TUKEY'S HSD POST HOC COMPARISONS FOR THE MAIN EFFECTS OF MODE OF REPRESENTATION BY WORD TYPE

	Image	Mixed	Percept
High Frequency Words	6.27	5.11	3.63
Image		1.16*	2.64**
Mixed			1.48**
Percept			
Pseudowords	6.50	4.65	3.27
Image		1.85**	3.23**
Mixed			1.38**
Percept			

* $p < .05$
** $p < .01$
Critical Differences: .05 = .97
.01 = 1.22

Ability by Age (AC) Interaction

Since the ability by age interaction is significant in the overall analysis, it will be reviewed even though no research questions were proposed for it. Analysis of simple effects (Appendix D, Table XVII) indicates significant ability differences in response time for nine year olds (A at c_1) and significant age differences in response time at each ability level (C at a_i) occurred. Comparisons of cell means (Appendix D, Table XVIII) for the significant simple effects suggests that nine year olds of high ability took less time to process words than those of low ability. In addition, high ability fourteen year olds took less time to process words than high ability nine year olds and low ability fourteen year olds took less time to process words than low ability nine year olds.

Strength of Association

A rough estimate of the strength of association, eta squared (η^2), was calculated for significant main effects and interactions (Linton and Gallo, 1975) and these values appear in Appendix E, Table XIX. It can be seen that 26.6% of the variance in the sample is due to age variation (C) and 29.9% of the variance is due to mode of representation (D); however, only 4.4% of the variance is due to the Age by Mode (CD) interaction. The strength of association for the Word Type by Mode (BD) interaction is quite insignificant, i.e., 0.5%.

Incorrectly Processed Responses

A summary of the analysis of variance for incorrectly processed responses is presented in Appendix F, Table XXI. As can be seen from this table, all between subjects main effects and two-way interactions are significant. None of the within subjects sources are significant.

The breakdown of the simple effects of the Ability by Age (AC) interaction indicates that ability makes a significant difference in response time of nine year olds (A at c_1) for incorrectly processing words and that age makes a significant difference in response time for low ability students (C at a_2) in incorrectly processing words (Appendix F, Table XXII). Comparison of means (Appendix F, Table XXIII) for the two levels of ability in nine year olds shows that nine year old students of low ability took longer to incorrectly process words than those of high ability. Comparison of means of the two age levels of low ability shows that low ability nine year olds took longer to incorrectly process words than low ability fourteen year olds.

The simple effects breakdown for the Ability by Mode (AD) interaction (Appendix F, Table XXIV) indicates that ability makes a significant difference in response time for incorrectly processing words in the imaginal and mixed modes (A at d_2 and A at d_3). Mode of representation appears to make a significant difference in response time of low ability students for incorrectly processing words (D at a_2). Comparison of means (Appendix F, Table XXV) for the two ability levels at both the imaginal and mixed modes (d_2 and d_3) shows that low ability students took longer to incorrectly process words in the two modes than high ability students. Tukey's HSD post hoc comparisons of mode of representation in low ability students (Appendix F, Table XXVI) indicates that low ability students took longer to incorrectly process words in the imaginal mode than in the mixed or percept mode. In addition, low ability students took longer to incorrectly process words in the mixed mode than in the percept mode.

Analysis of the simple effects breakdown of the Age by Mode (CD) interaction (Appendix F, Table XXVII) indicates a significant age difference in response time for incorrectly processing words in the imaginal mode (C at d_2) and a significant mode of representation difference in time for incorrectly processing words in nine year olds (D at c_1). Comparisons of means (Appendix F, Table XXVIII) for the two age levels for the imaginal mode demonstrates that nine year olds took longer to incorrectly process words in the imaginal mode than fourteen year olds. Tukey's HSD post hoc comparisons of mode for nine year olds (Appendix F, Table XXIX) shows that nine year olds took longer to incorrectly process words in the imaginal mode than in the mixed or percept mode. In addition, nine year olds took longer to incorrectly process words in the mixed mode than percept mode.

Strength of association, eta squared (η^2), values for significant main effects and interactions appear in Appendix E, Table XX. It can be seen that mode (D) accounts for 16.4% of the variance in the sample while each of the significant interactions accounts for less than 10% of the total variance.

Recall

A summary of the analysis of variance in which correct recall is the dependent variable is presented in Table XI. The dependent variable of correct recall is defined as the number of words correctly recalled upon request. As can be seen from this table, three main effects, Age (C), Mode (D) and Word Type (F) are significant. Two of the two-way interactions, Ability by Age (AC) and Word Type by Mode (FD) are also significant.

Hartley's F_{max} test for testing the assumption of homogeneity of error variance for the two error terms (Subj. w. Groups and F x Subj. w. Groups) is not significant, $F = 1.90$, $p > .05$, indicating that the error variances are homogeneous. Since the error variances are homogeneous, they were pooled when testing for simple effects of the Word Type by Mode interaction which contains the repeated measure, word type.

TABLE XI

SUMMARY TABLE FOR THE ANALYSIS OF VARIANCE
FOR THE DEPENDENT VARIABLE
OF CORRECT RECALL

Source	SS	df	MS	F	p
Between Subjects	361.9947	95			
A (Ability)	7.1302	1	7.130	2.53	.0001
C (Age)	47.0052	1	47.005	16.70	.0051
D (Mode)	31.6354	2	15.818	5.62	.0064
A x C	22.0052	1	22.005	7.82	
A x D	13.1979	2	6.599	2.34	
C x D	2.8229	2	1.412	.50	
A x C x D	1.7604	2	.880	.31	
Subj. w. Groups	236.4375	84	2.815		
Within Subjects	176.5000	96			
F (Word Type)	27.7552	1	27.755	18.77	.0001
A x F	.8802	1	.880	.60	
F x C	.2552	1	.255	.17	
F x D	16.3229	2	8.162	5.52	.0056
A x F x C	1.1719	1	1.172	.79	
A x F x D	.5104	2	.255	.17	
F x C x D	.1354	2	.068	.05	
A x F x C x D	5.2813	2	2.641	1.79	
F x Subj. w. Groups	124.1875	84	1.478		
Total	538.4947	191			

Research Question Three deals with the dependent variable of recall and focuses on the main effect, Mode (D) of representation. In addition to reporting results pertinent to this question, this section will also review the Ability by Age (AC) interaction, provide strength of association values for significant main effects and interactions and examine recall of incorrect words.

Research Question Three

Research Question Three asks: Are the number of words correctly recalled related to the mode of representation used in processing the words? The significant main effect of mode of representation (D) indicates a relationship to correct recall. Therefore, the corresponding null Hypothesis III stating that there will be no difference in number of words correctly recalled as a function of the mode of representation is rejected for the present study. Tukey's HSD post hoc comparisons of mean number of words recalled at each mode of representation (Table XII) indicates that more words were correctly recalled in the imaginal mode than in the mixed or percept mode; no other differences were found.

TABLE XII

MEAN NUMBER OF TOTAL WORDS CORRECTLY RECALLED AND TUKEY'S HSD POST HOC COMPARISONS FOR THE MAIN EFFECT OF MODE OF REPRESENTATION (D)

	Image	Mixed	Percept
	3.98	3.16	3.09
Image		.82*	.89*
Mixed			.06
Percept			

* $p < .05$
Critical Difference: .05 = .71

The significant Word Type by Mode (FD) interaction provides further insight into the amount of recall as a function of mode. The breakdown of simple effects (Table XIII) indicates that differences in word type contribute significantly to correct recall in the imaginal and mixed modes of representation (F at d_2 and F at d_3). In addition, mode of representation appears to contribute significantly to correct recall of high frequency words (D at f_1). Comparison of cell means for the two word types processed in both imaginal and mixed modes (Table XIV) shows that students recalled more words from the high frequency word list than from the pseudoword list in both the modes. Tukey's HSD post hoc comparisons of mode for high frequency words suggests that more words were correctly recalled in the imaginal mode than in the mixed or percept modes (Table XV).

TABLE XIII

SIMPLE EFFECTS BREAKDOWN FOR WORD TYPE (F) BY MODE OF REPRESENTATION (D) INTERACTION FOR THE DEPENDENT VARIABLE OF CORRECT RECALL

Source	SS	df	MS	F
F at d_1	.062	1	.06	.028
F at d_2	23.765	1	23.77	11.056**
F at d_3	20.249	1	20.25	9.419**
D at f_1	37.770	2	18.89	8.419**
D at f_2	10.187	2	5.09	2.367
Pooled Error		168	2.15	

** $p < .01$

TABLE XIV

MEAN NUMBER OF WORDS CORRECTLY RECALLED IN THE WORD TYPE (F) BY MODE (D) INTERACTION

	Percept	Image	Mixed
High Frequency Words	3.063	4.594	3.719
Pseudowords	3.125	3.375	2.594

TABLE XV

MEAN NUMBER OF HIGH FREQUENCY WORDS CORRECTLY RECALLED AND TUKEY'S HSD POST HOC COMPARISONS FOR THE MAIN EFFECT OF MODE (D)

	Image	Mixed	Percept
	4.594	3.719	3.063
Image		.875**	1.531**
Mixed			.656*
Percept			

* $p < .05$
** $p < .01$
Critical Differences: .05 = .615
.01 = .769

Ability by Age (AC) Interaction

Since the Ability by Age (AC) interaction is significant in the overall analysis, it will be reviewed even though no research questions were proposed for it. The breakdown of simple effects (Appendix G, Table XXX) indicates that ability contributes significantly to correct recall in fourteen year olds (A at c_2) and that age contributes significantly to correct recall in high ability students (C at a_1). Comparison of cell means (Appendix G, Table XXXI) for the two levels of ability in fourteen year olds demonstrates that high ability fourteen year olds recalled more words than low ability fourteen year olds. Comparison of means for the two age levels of high ability (a_1) shows that high ability fourteen year olds recalled more words than high ability nine year olds.

Strength of Association

A rough estimate of the strength of association, eta squared (η^2), was calculated for significant main effects and interactions. These values appear in Appendix E, Table XIX. It can be seen that 5.9% of the variance in the sample is due to mode of representation.

Incorrect Recall

A summary of the analysis of variance in which incorrect recall is the dependent variable is presented in Appendix H, Table XXXII. As can be seen from this table, no main effects are significant and only one interaction, Ability by Word Type (AF), is significant.

Hartley's F_{max} for testing the assumption of homogeneity of error variance for the two error terms (Subj. w. Groups and F x Subj. w. Groups) is not significant, $F = 1.18$, $p > .05$, indicating that the error variances are homogeneous. Since the error variances are homogeneous, they were pooled for testing simple effects of the Ability by Word Type interaction.

The simple effects breakdown of the Ability by Word Type (AF) interaction (Appendix H, Table XXXIII) indicates that differences in ability contributes significantly to incorrect recall of pseudowords (A at f_2) and differences in word type contribute significantly to incorrect recall in low ability students (F at a_2). Comparison of cell means (Appendix H, Table XXXIV) for the two levels of ability on the pseudoword list shows that the low ability students provided more incorrect responses during recall of pseudowords than high ability students. Comparison of means for the two types of words by low ability students indicates that low ability students provided more incorrect responses in recall of pseudowords than high frequency words.

A strength of association value (η^2) was calculated for the Ability by Word Type (AF) interaction and appears in Appendix E, Table XX. It can be seen that only 2.2% of the variance in the sample is due to the Ability by Word Type interaction.

Spelling

A summary of the analysis of variance in which correct spelling is the dependent variable is presented in Table XVI. The dependent variable of correct spelling is defined as the number of words correctly written from dictation. As can be seen from this table, three main effects, Ability (A), Age (C), Word Type (G) and two interactions, Ability by Word Type (AG) and Word Type by Age (GC) are significant.

TABLE XVI

SUMMARY TABLE FOR THE ANALYSIS OF VARIANCE
FOR THE DEPENDENT VARIABLE
OF CORRECT SPELLING

Source	SS	df	MS	F	p
Between Subjects	225.9792	95			
A (Ability)	24.0833	1	24.083	13.79	.0001
C (Age)	42.1875	1	42.188	24.15	.0001
D (Mode)	5.0417	2	2.509	1.44	
A x C	4.0833	1	4.083	2.34	
A x D	.6667	2	.334	.19	
C x D	2.6250	2	1.313	.75	
A x C x D	.5417	2	.271	.16	
Subj. w. Groups	146.7500	84	1.747		
Within Subjects	156.0000	96			
G (Word Type)	82.6875	1	82.688	115.75	.0001
A x G	4.0833	1	4.083	5.72	.0190
G x C	4.6875	1	4.688	6.56	.0122
G x D	2.0000	2	1.000	1.40	
A x G x C	.3333	1	.333	.47	
A x G x D	.5417	2	.271	.38	
G x C x D	.8750	2	.438	.61	
A x G x C x D	.7917	2	.396	.55	
G x Subj. w. Groups	60.0000	84	.714		
Total	381.9792	191			

Hartley's F_{max} test for testing the assumption of homogeneity of error variance for the two error terms (Subj. w. Groups and G x Subj. w. Groups) is not significant, $F = 2.45$, $p > .05$, indicating that the error variances are homogeneous. Therefore, the two error variances were pooled when testing for simple effects of the interactions involving the repeated measure, word type.

Research Question Five focuses on the main effect, Mode of Representation (D). In addition to reporting results pertinent to this question, this section will also review the Ability by Word Type (AG) interaction and the Word Type by Age (GC) interaction, provide strength of association values for significant main effects and interactions and examine incorrect spelling of words.

Research Question Five

Research Question Five asks: Are the number of words spelled correctly related to the mode of representation used in processing the words? The main effect for mode of representation (D) is not significant indicating no relationship to the number of words spelled correctly. Therefore, the corresponding null Hypothesis V stating that there will be no difference in the number of words spelled correctly as a function of the mode of representation cannot be rejected for the present study.

Ability by Word Type (AG) Interaction

Since the Ability by Word Type (AG) interaction is significant in the overall analysis, it will be reviewed even though no research questions were proposed for it. The simple effects breakdown of the Ability by Word Type interaction (Appendix I, Table XXV) indicates that ability contributes significantly to the number of pseudowords spelled correctly (A at g_2) and that word type contributes significantly to correct spelling at both ability levels (G at a_i). Comparison of means (Appendix I, Table XXXVI) for the two levels of ability for pseudowords shows that high ability students spelled more pseudowords correctly than did low ability students. Comparison of means for the two types of words by ability shows that both high ability and low ability students spelled more high frequency words correctly than pseudowords.

Word Type by Age (GC) Interaction

Since the Word Type by Age (GC) interaction is significant in the overall analysis, it will be reviewed even though no research questions were proposed for it. The simple effects breakdown (Appendix I, Table XXXVII) indicates that differences in word type contribute to correct spelling at both age levels (G at c_k) and that age differences contribute to the number of words spelled correctly in each word type list (C at g_n). Comparison of means (Appendix I, Table XXXVIII) for the two types of words for both age levels shows that both nine year olds and fourteen year olds spelled more high frequency words correctly than pseudowords. Comparison of means for the two ages on both word types demonstrates that fourteen year olds correctly spelled more high frequency and pseudowords than nine year olds.

Strength of Association

A rough estimate of the strength of association, eta squared (η^2), was calculated for significant main effects and interactions. These values appear in Appendix E, Table XIX. It can be seen that word type

(G) accounts for 21.6% of the variance in the sample and age (C) accounts for 11.0%. The strength of association for the two interactions is quite insignificant, e.g., approximately 1.0% each.

Incorrect Spelling

A summary of the analysis of variance in which incorrect spelling is the dependent variable is presented in Appendix J, Table XXXIX. The dependent variable of incorrect spelling is defined as including both misspelled words and words which were not attempted. As can be seen from the table, three main effects, Ability (A), Age (C) and Word Type (G) are significant. Two of the two-way interactions, Ability by Word Type (AG) and Word Type by Age (GC) are also significant.

Hartley's F_{max} test for testing the assumption of homogeneity of error variance for the two error terms (Subj. w. Groups and G x Subj. w. Groups) is not significant, $F = 2.43$, $p > .05$, indicating that the error variances are homogeneous. Since the error variances are homogeneous, they were pooled when testing for simple effects of the two interactions, Ability by Word Type and Word Type by Age.

The simple effects breakdown for the Ability by Word Type (AG) interaction (Appendix J, Table XL) indicates that ability contributes significantly to the number of pseudowords incorrectly spelled (A at g_2) and that word type contributes to the number of words incorrectly spelled at each age level (G at a_i). Comparison of means (Appendix J, Table XLI) shows that low ability students incorrectly spelled more pseudowords than high ability students. In addition, more pseudowords were incorrectly spelled than high frequency words at both ability levels.

The simple effects breakdown for the Word Type by Age (GC) interaction (Appendix J, Table XLII) indicates that word type contributes significantly to the number of incorrectly spelled words at both age levels (G at c_k) and that age contributes significantly to the number of incorrectly spelled words at both word types (C at g_n). Comparison of cell means (Appendix J, Table XLIII) shows that nine year olds spelled more words incorrectly on both word type lists than fourteen year olds. In addition, both age levels spelled more pseudowords incorrectly than high frequency words.

Strength of association values were calculated for the significant main effects and interactions. These values appear in Appendix E, Table XX. It can be seen that these values follow the same trend as the corresponding main and treatment effects for words correctly spelled.

CHAPTER V

SUMMARY AND DISCUSSION

Summary

This study examined possible differences in perceptual and imaginal representation of two types of words, high frequency words and pseudowords, in two age levels of children, nine year olds and fourteen year olds, representing two reading ability levels, high and low. Specifically, a major purpose of this study was to examine the possible influence of perceptual and imaginal representation of words in processing and recall of words. Weber et al.'s (1981) percept-first development hypothesis provided the basic perspective from which to investigate these issues.

The participants in this study were 48 nine year olds and 48 fourteen year olds. Half of the subjects in each age level were classified as high ability readers and half as low ability readers on the basis of total reading scores they obtained on school administered reading tests, the Gates-MacGinitie Reading Tests. These 96 subjects were enrolled in the third and eighth grades in two school districts located in northeastern Oklahoma (Inola and Union Public School districts) during the spring semester, 1982.

Subjects were randomly assigned to one of three experimental conditions for mode of representation (percept, mixed, image). Each subject was seen individually for one session; experimental sessions averaged 20 minutes. Upon entering the experimental session, all subjects were given training instructions for height of lowercase letters (ascenders called "up", descenders called "down" and the remaining letters were called "flat"). Then subjects were given instructions for their particular experimental condition and engaged in a series of activities for two consecutively presented word type lists, high frequency words and pseudowords. The activities for each word list involved reading the words, processing them according to height of letter, recalling the words and spelling them from dictation. Subjects in the percept condition looked at each word printed in lowercase letters while responding for height. Subjects in the image condition were orally presented each word and had to imagine it printed in lowercase letters in order to comply with task demands. Subjects in the mixed condition looked at each word printed in capital letters and had to imagine it printed in lowercase letters in order to comply with task demands; the mixed condition was instituted to serve as a control group for the other two conditions.

Five research questions were presented to investigate differences in imaginal and percept representation on processing and recall of words. These questions focused on differences in correct response time between the two modes as a function of age, ability and word type as well as the relationship of mode of correct recall and correct spelling of words. These research questions were investigated by the use of a split-plot factorial (SPF-pru.q) design (Kirk, 1968) with the last factor, word type, as a repeated measure. Separate split-plot analyses were conducted for each of three dependent variables: correct response time, correct recall and correct spelling.

There were differences in time for correctly processing words in the percept and imaginal modes between the two age levels, Age by Mode (CD) interaction. Nine year olds took longer to process words in all three modes than fourteen year olds and both age levels took longer to process words in the imaginal mode than in the percept mode. Therefore, the first null hypothesis was rejected.

The second null hypothesis could not be rejected in relation to the Ability by Mode (AD) interaction for correct response time, i.e., no differences in time for processing in percept and imaginal modes were found as a function of ability. However, differences in ability were found in a higher order interaction, Ability by Word Type by Mode (ABD) interaction. Both ability levels took longer to process both word types, high frequency words and pseudowords, in the imaginal mode than percept mode. In addition, low ability students took longer than high ability students to process pseudowords in the imaginal mode.

As can be seen from the significant main effect of Mode (D) for correct recall, there were differences in number of words recalled as a function of mode of representation for processing the words. Imaginal representation enhanced recall. Therefore, the third null hypothesis was rejected.

The fourth null hypothesis was also rejected. The significant Word Type by Mode (BD) interaction for correct response time suggests that time for correctly processing words by mode does vary with word type. The difference was found to be primarily due to mode, i.e., it took longer to process both types of words in the imaginal mode than percept mode.

There were no differences found in number of words correctly spelled as a function of mode of representation. Therefore, the fifth null hypothesis was not rejected.

Discussion

General Comments

In reviewing the results, it should be remembered that the group of nine year old subjects was primarily male, i.e., 62.5%, while the group of fourteen year old subjects was more equally balanced for sex. In addition, the entire sample was predominately Caucasian.

There were individual differences in the subjects' ability to use the coding system of "up, down and flat" for letter height on the stimulus words. Low ability nine year old subjects gave a variety of responses: high, low, flat; above, below, sits on the line; high, low, middle; top, bottom, flat; and tall, short, long. Such coding systems were accepted as correct for processing words by letter height since they conveyed the same concept.

Response Time

With regard to the significant Age by Mode (CD) interaction for correct response time, it was noted that nine year olds took longer to process words in each mode than fourteen year olds and that both age levels took longer to process words in the imaginal mode than percept mode. The longer response time required by nine year olds to process the words regardless of mode is consistent with Piaget's work on perceptual decentration and increased efficiency in processing information with age (Wadsworth, 1979). In addition, the mean number of high frequency and pseudowords correctly processed by fourteen year olds was approximately the same in both percept and imaginal modes while the mean number of words correctly processed by nine year olds was less in the imaginal than percept mode. These findings indicate that the percept system matures prior to the imaginal system and are consistent with Weber et al.'s (1981) percept-first development hypothesis.

Although the Ability by Mode (AD) interaction for correct responses was not significant, the Ability by Word Type by Mode (ABD) interaction was significant. It was noted that low ability students took longer to process pseudowords in the imaginal mode than high ability students; the ability levels did not differ significantly in processing high frequency words in the imaginal mode. This difference suggests that the imaginal system of low ability students is not as adept at processing novel words as it is for high ability students.

The significant Word Type by Mode (BD) interaction was found to be due primarily to the effects of mode of representation rather than word type. It took students longer to process both types of words in the imaginal than percept mode. Therefore, it does appear that it takes longer to imagine words by height of letter regardless of word type, i.e., high frequency or pseudoword.

The significant Ability by Age (AC) interaction, though not hypothesized, was not surprising. The interesting point was that it took low ability nine year olds longer to process words incorrectly, as well as correctly, than high ability nine year olds or low ability fourteen year olds.

The results for response time cannot be accounted for due to speed-accuracy trade off. As can be seen from Tables XLIV and XLV in Appendix

K, shorter time scores were accompanied by higher accuracy scores. In addition, longer time scores were accompanied by higher error scores (Appendix L, Tables L and LI).

Recall

Subjects in the imaginal mode recalled significantly more words correctly than subjects in the percept mode. Specifically, subjects recalled more high frequency than pseudowords in the imaginal mode; this finding is consistent with research indicating that high frequency words are easier to recall than low frequency (Brown, 1976). However, it should be noted that the statistical difference involved approximately one more word. The practical significance of this difference in amount of recall is beyond the scope of the present study.

The significant Ability by Age (AC) interaction, though not hypothesized, was not surprising. High ability fourteen year olds correctly recalled more words than low ability fourteen year olds or high ability nine year olds. The age difference in recall is consistent with research on developmental trends in memory (Hagen, Jongeward and Kail, 1975; Reese, 1976). The ability difference is consistent with research on the interaction of perception and memory as related to reading ability (Burks and Bruce, 1955). It does appear that pattern recognition, i.e., word shape, facilitates recall of words in more skilled readers. The ability of skilled readers to utilize pattern recognition in their word processing skills is consistent with the work by Gibson (1976) and Piaget (Wadsworth, 1979) on increased efficiency in processing information with age and experience.

Spelling

The lack of a significant difference in number of words correctly spelled as a function of mode of representation was somewhat disappointing. There are, perhaps, two reasons for this finding. First of all, word shape, as represented by the imaginal mode, may not be related to the ability to correctly write words from dictation. Secondly, naive experimental technique could have set up a concurrent spatial task which Brooks (1968) has found disrupts recall in short term memory. Asking subjects to "spell words", i.e., write them from dictation, after having them process words by "spelling them by height of letter" could have negated any differences that may have existed due to mode.

The finding of a significant Ability by Word Type (AG) interaction was not surprising. Both ability levels spelled approximately one more high frequency word correctly than pseudowords and the high ability group spelled approximately one more pseudoword correctly than the low ability group. These findings are consistent with research on recall of high and low frequency words (Brown, 1976) and reading ability and memory (Burks and Bruce, 1955; Morrison, Giordani and Nagy, 1977).

The significant Word Type by Age (GC) interaction was not surprising either. Both age levels spelled approximately one more high frequency word correctly than pseudowords as would be expected based on research involving recall of high and low frequency words (Brown, 1976). In addition, fourteen year olds spelled approximately one more word correctly on both lists than nine year olds; this finding is consistent with research on developmental trends in memory (Hagen, Jongeward and Kail, 1975; Reese, 1976).

Relationship of Results to Purpose of the Study

The purpose of the study focused on two questions regarding utilization of word shape in word perception skills. These questions inquired about a developmental trend in utilization of word shape and whether differences in mode of processing the configuration of words could influence recall of them.

With regard to the first question, subjects took longer to correctly process words by height of letter in the imaginal versus percept mode and nine year olds took longer to correctly process words in the imaginal mode than fourteen year olds. These results were shown not to be due to a speed-accuracy trade off. It was pointed out that these results were consistent with the percept-first development hypothesis (Weber et al., 1981). It was also pointed out that longer response times by nine year olds for processing words were consistent with Piaget's (Wadsworth, 1979) work on perceptual decentration and increased efficiency in processing information with age. If it is assumed that word shape can be processed as a visual image, there does appear to be an age related developmental trend in children's ability to process words on the basis of configurational cues, i.e., fourteen year olds appear to be more adept at such skills than nine year olds. There also appears to be a reading ability related trend for pseudowords, i.e., novel low frequency words; low ability subjects took longer to process pseudowords by shape in the imaginal mode than high ability subjects.

With regard to the second question, results showed that the mental process, i.e., mode of representation, by which the configuration of words were processed did influence children's ability to recall them. Children at both age levels recalled more words following the imaginal mode than percept mode. It should be noted that while the imaginal mode yielded more recall, the response time was also higher. Therefore, more processing yielded more recall which is consistent with Lockhart et al.'s (1976) theory of memory. Correlational data on the dependent variable of correct recall and the Gates-MacGinitie test scores (Appendix M, Tables LVII and LIX) indicates that there is a tremendous increase in the ability to extract perceptual information between the ages of nine and fourteen. It does appear that the increased ability to extract perceptual information with increasing age is related to reading ability as proposed by Gibson and Levin (1975). Perhaps, imaginal representation helps organize salient perceptual aspects of words which, in turn, increases memory for the words.

In summary, it appears that fourteen year old children are better able to process words on the basis of shape than nine year olds. However, recall of words can be enhanced in both age levels by instructing the students to process the shape of the word as a visual image. As a result of these findings, it is suggested that classroom teachers consider focusing more attention on helping students attend to salient perceptual aspects of words as they work on word recognition skills in reading.

Conclusions

The following five conclusions are suggested by the results of this study:

1. It takes longer to imagine words by height of letter than to

directly perceive them. It took all subjects longer to correctly process both high frequency and pseudowords in the imaginal mode than in the percept mode.

2. Fourteen year olds have a better developed imaginal capacity for processing words by shape than nine year olds. Fourteen year olds took less time to correctly process words in the imaginal mode than nine year olds.

3. High ability students have a greater imaginal capacity for processing pseudowords by shape than low ability students. Low ability students took longer to process pseudowords in the imaginal mode than high ability students.

4. Encoding words by the imaginal mode appears to enhance recall in short term memory. Both age levels recalled more words following the imaginal mode than the percept mode.

5. Word shape, as represented by the imaginal mode of representation, does not appear to be a determining factor in the ability to correctly write words from dictation. There was no difference in the number of words correctly spelled as a function of mode of representation.

Recommendations for Future Research

It is recommended that future research be considered in the following four areas:

1. Clarification of the relationship between reading ability and imaginal representation for processing words by height of letter. Although the Ability by Mode (AD) interaction was not significant for correct response time, it was significant for incorrect response time.

Low ability students took longer to incorrectly process words in the imaginal mode than high ability students. It is suggested that the dichotomy of high and low ability is not sensitive enough to detect differences in correct response time for processing words. It is recommended that future research consider a minimum of three ability levels, i.e., high, average and low, in order to have a clear break between ability categories.

2. It is also recommended that additional research be done to verify the lack of relationship between the number of words spelled correctly and mode of representation in which they were earlier processed. Correlational data for words correctly and incorrectly spelled and total reading scores on the Gates-MacGinitie Test for nine year olds (Appendix M, Table LX and Appendix N, Table LXVI) indicates that 47.6% of the variance in total reading is related to spelling of words processed in the imaginal mode. It is suggested that instructions for processing the words be changed from "spell by height of letter" to "tell me the height of each letter beginning with the first letter." It is also suggested that the response time for writing each word from dictation be maintained; the mean response time for writing the spelling words may be a more sensitive method of discerning any possible differences that may exist due to mode of processing.

3. It is also recommended that a parallel line of research be considered for investigating a possible trend in the development of auditory imagery as related to reading.

4. It is further recommended that future research consider studying the rates at which school age children develop auditory and visual imagery systems. Knowing whether the two imagery systems develop at

the same or different rates can provide reading experts greater insight into when children are best equipped to utilize phonetic and whole word methods in word recognition skills.

BIBLIOGRAPHY

Allen, B. E. Influence of imagery on semantic-memory abilities. Proceedings, 80th Annual Convention, APA, 1972.

Anderson, J. R. Arguments concerning representations for mental imagery. Psychological Review, 1978, 85, 249-277.

Arnold, E., McNinch, G., & Miller, W. Experiments in word learning. In P. D. Pearson & J. Hansen (Eds.), Reading: Disciplined inquiry in process and practice. Clemson, S. C.: The National Reading Conference, Inc., 1978.

Belham, W. E., & Ross, A. O. Selective attention in children with reading problems: A developmental study of incidental learning. Journal of Abnormal Child Psychology, 1977, 5, 1-8.

Bower, G. H. Mental imagery and associative learning. In L. W. Gregg (Ed.), Cognition in learning and memory. New York: John Wiley & Sons, Inc., 1972.

Brooks, L. R. Spatial and verbal components of the act of recall. Canadian Journal of Experimental Psychology, 1968, 22, 349-368.

Brooks, L. R. The suppression of visualization by reading. Quarterly Journal of Experimental Psychology, 1967, 19, 289-299.

Brown, A. L. The development of memory: Knowing, knowing about knowing, and knowing how to learn. In H. W. Reese (Ed.), Advances in child development and behavior, 1978, 10, New York: Academic Press.

Brown, J. (Ed.). Recall and recognition. New York: John Wiley & Sons, 1976.

Burks, H. F., & Bruce, P. The characteristics of poor and good readers as disclosed by the Wechsler Intelligence Scale for Children. Journal of Educational Psychology, 1955, 46, 488-493.

Chipman, S. F., & Mendelson, M. J. The development of sensitivity to visual structure. Journal of Experimental Child Psychology, 1975, 20, 411-429.

Cramer, E. H. Mental imagery, reading attitude and comprehension. Reading Improvement, 1980, 17, 135-139.

Cromer, W. The difference model: A new explanation for some reading difficulties. Journal of Educational Psychology, 1970, 61, 471-483.

Developmental Psychology Today. Del Mar, CA.: Communications Research Machines, Inc., 1971.

Elliot, S. N., & Carroll, J. L. Strategies to help children remember what they read. Reading Improvement, 1980, 17, 272-277.

Estes, W. K. On the interaction of perception and memory in reading. In D. LaBerge & S. J. Samuels (Eds.), Basic processes in reading: Perception and comprehension. Hillsdale, N. J.: Lawrence Erlbaum Associates, 1977.

Fisher, V. L., & Price, J. H. Cues to word similarity used by children and adults: Supplementary report. Perceptual and Motor Skills. 1970, 31, 849-850.

Gagne, Robert M. The conditions of learning. New York: Holt, Rinehart & Winston, Inc., 1965.

Gibson, E. J. Trends in perceptual development: Implications for the reading process. In H. Singer & R. B. Ruddell (Eds.), Theoretical models and processes of reading (2nd ed.). Newark, DL.: International Reading Association, 1976.

Gibson, E. J., Gibson, J. J., Pick, A. D., & Osser, H. A developmental study of the discrimination of letter-like forms. Journal of Comparative and Physiological Psychology, 1962, 55, 897-906.

Gibson, E. J., & Levin, H. The psychology of reading. Cambridge, MA.: The MIT Press, 1975.

Gough, P. B. One second of reading. In H. Singer & R. B. Ruddell (Eds.), Theoretical models and processes of reading (2nd ed.). Newark, DL.: International Reading Association, 1976.

Hagen, J. W., Jongeward, R. H., Jr., & Kail, R. V., Jr. Cognitive perspectives on the development of memory. In H. W. Reese (Ed.), Advances in child development and behavior, 1975, 10, New York: Academic Press.

Hagen, J. W., & Sabo, R. A developmental study of selective attention. Merrill-Palmer Quarterly, 1967, 13, 159-172.

Harris, A. J., & Jacobson, M. D. Basic vocabulary for beginning reading. The Reading Teacher, 1973, 26, 392-395.

Hartley, R. N. Effects of list types and cues on the learning of word units. Reading Research Quarterly, 1970, 6, 97-121.

Hebb, D. O. Concerning imagery. Psychological Review, 1968, 75, 466-477.

Higbee, K. L. A century of research on mnemonics: We're back where we started. (Paper presented at the Western Psychological Association, Los Angeles, CA., April, 1976. Microfilm copy.)

Higbee, K. L. Recent research on visual mnemonics: Historical roots and educational fruits. Review of Educational Research, 1979, 49, 611-629.

Higbee, K. L. Your memory. How it works and how to improve it. Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1977.

Hollenberg, C. K. Functions of visual imagery in the learning and concept formation of children. Child Development, 1970, 41, 1003-1015.

Ives, J. P., Bursuk, L. Z., & Ives, S. A. Word identification techniques. Chicago: Rand McNally College Publishing Co., 1979.

Jacob, S. H. Contexts and images in reading. Reading World, 1976, 15, 167-175.

Johnson, R. E. Abstractness-concreteness in the recall of textual prose. Proceedings, 80th Annual Convention, APA, 1972.

Jorm, A. F. Effect of word imagery on reading performance as a function of reader ability. Journal of Educational Psychology, 1977, 69, 46-54.

Katz, L., & Wicklund, D. A. Letter scanning rate for good and poor readers in grades two and six. Journal of Educational Psychology, 1972, 63, 363-367.

Katz, L., & Wicklund, D. Memory-scanning differences and picture versus word encoding for good and poor readers. Proceedings, 81st Annual Convention, APA, 1973.

Kirk, R. E. Experimental design: Procedures for the behavioral sciences. Belmont, CA.: Brooks/Cole, 1968.

Kolers, P. Pattern-analyzing disability in poor readers. Developmental Psychology, 1975, 11, 282-258.

Kolker, B., & Terwilliger, P. N. Sight vocabulary learning of first and second graders. Reading World, 1981, 20, 251-258.

Kosslyn, S. M. Image and mind. Cambridge, MA.: Harvard University Press, 1980.

Kosslyn, S. M., & Pomerantz, J. R. Imagery, propositions, and the form of internal representations. Cognitive Psychology, 1977, 9, 52-76.

LaBerge, D., & Samuels, S. J. Toward a theory of automatic information processing in reading. Cognitive Psychology, 1974, 6, 293-323.

Lachman, R., Lachman, J. L., & Butterfield, E. C. Cognitive psychology and information processing. An introduction. Hillsdale, N.J.: Lawrence Erlbaum Associates, 1979.

Levin, J. R., & Devine-Hawkins, P. Visual imagery as a prose-learning process. Journal of Reading Behavior, 1974, 6, 23-30.

Linton, M., & Gallo, P. S., Jr. The practical statistician. Simplified handbook of statistics. Monterey, CA.: Brooks/Cole, 1975.

Lockhart, R. S., Craik, F. I. M., & Jacoby, L. Depth of processing, recognition and recall. In J. Brown (Ed.), Recall and recognition. New York: John Wiley & Sons, Inc., 1976.

McCoy, K. M., & Weber, R. J. Image and perceptual representation of words in learning disabled and normal children. Learning Disability Quarterly, 1981, 4, 76-81.

McKelvie, S. J., & Demers, E. G. Individual differences in reported visual imagery and memory performance. British Journal of Psychology, 1979, 70, 51-57.

Mackworth, J. F. Some models of the reading process: Learners and skilled readers. In F. B. Davis (Ed.), Final report. The literature of research in reading with emphasis on models. New Brunswick, N. J.: The Graduate School of Education, Rutgers--The State University, 1971.

Miccinati, J. Teach reading disabled students to perceive distinctive features in words. Journal of Learning Disabilities, 1981, 14, 140-142.

Monroe, M. Children who cannot read. Chicago: The University of Chicago Press, 1932.

Morrison, F. J., Giordani, B., & Nagy, J. Reading disability. An information-processing analysis. Science, 1977, 196, 77-79.

Neisser, U. Cognitive psychology. New York: Appleton-Century-Crofts, 1967.

Oakan, R., Wiener, M., & Cromer, W. Identification, organization and reading comprehension for good and poor readers. Journal of Educational Psychology, 1971, 62, 71-78.

Pace, A. J., & Golinkoff, R. M. Relationship between word difficulty and access of single-word meaning by skilled and less skilled readers. Journal of Educational Psychology, 1976, 68, 760-767.

Paivio, A. A dual coding approach to perception and cognition. In H. L. Pick, Jr. & E. Saltsman (Eds.), Modes of perceiving and processing information. Hillsdale, N. J.: Lawrence Erlbaum Associates, 1978.

Paivio, A. Imagery and language. In S. J. Segal (Ed.), Imagery. Current cognitive approaches. New York: Academic Press, 1971.

Paivio, A. Imagery in recall and recognition. In J. Brown (Ed.), Recall and recognition. New York: John Wiley & Sons, Inc., 1976.

Paivio, A., Yuille, J. C., & Madigan, S. Concreteness, imagery and meaningfulness values for 925 nouns. Journal of Experimental Psychology Monograph Supplements, 1968, 76.

Piaget, J., & Inhelder, B. Mental imagery in the child. A study of the development of imaginal representation. New York: Basic Books, Inc., 1971.

Pick, A. D. Improvement of visual and tactual form discrimination. Journal of Experimental Psychology, 1965, 69, 331-339.

Pollio, H. R. The psychology of symbolic activity. Reading, MA.: Addison-Wesley Publishing Co., 1974.

Pressley, M. Children's use of the keyword method to learn simple Spanish vocabulary words. Journal of Educational Psychology, 1977 (a), 69, 465-472.

Pressley, M. Imagery and children's learning: Putting the picture in developmental perspective. Review of Educational Research, 1977 (b), 47, 585-622.

Preston, K. The relation of visual imagery to Piaget's stages of cognitive development. (Paper presented at the Western Psychological Association, Seattle, Washington, April, 1977. Microfilm copy.)

Pylyshyn, Z. W. The imagery debate: Analogue media versus tacit knowledge. Psychological Review, 1981, 88, 16-45.

Radaker, L. D. Visual imagery as a factor in memory for word forms. (Doctoral dissertation, Pennsylvannia State University, University Park, August, 1959.)

Rayner, K. Developmental changes in word recognition strategies. Journal of Educational Psychology, 1976, 68, 323-329.

Rayner, K., & Hagelberg, E. M. Word recognition cues for beginning and skilled readers. Journal of Experimental Child Psychology, 1975, 20, 444-455.

Reese, H. W. (Chm.). Imagery in children's learning: A symposium. Psychological Bulletin, 1970, 73, 383-384.

Reese, H. W. The development of memory: Life-span perspectives. In H. W. Reese (Ed.), Advances in child development and behavior, 1976, 11, New York: Academic Press.

Rohwer, W. D., Jr. Images and pictures in children's learning: Research results and instructional implications. In H. W. Reese (Chm.), Imagery in children's learning: A symposium. Psychological Bulletin, 1970, 73, 393-403.

Ross, B. M., & Kerst, S. M. Developmental memory theories: Baldwin and Piaget. In H. W. Reese & L. P. Lipsitt (Eds.), Advances in child development and behavior, 1978, 12, New York: Academic Press.

Rubenstein, H., Garfield, L., & Millikan, J. A. Homographic entries in the internal lexicon. Journal of Verbal Learning and Verbal Behavior, 1970, 9, 487-494.

Ruch, M. D., & Levin, J. R. Partial pictures as imagery-retrieval cues in young children's prose recall. Journal of Experimental Child Psychology, 1979, 28, 268-279.

Samuels, S. J., & Jeffrey, W. E. Discriminability of words and letter cues in learning to read. Journal of Educational Psychology, 1966, 57, 337-340.

Santostefano, S., Rutledge, L., & Randal, D. Cognitive styles and reading disability. Psychology in the Schools, 1965, 2, 57-62.

Segal, S. J. Imagery. Current cognitive approaches. New York: Academic Press, 1971.

Smith, H. P., & Dechant, E. V. Psychology in teaching reading. Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1961.

Smith, H. P., & Dechant, E. V. Psychology in teaching reading (2nd ed.), Englewood Cliffs, N. J.: Prentice-Hall, 1977.

Stauffer, L., & Stauffer, J. D. An analysis of letter reversals in children and a model for an approach to remediation. Journal of Learning Disabilities, 1981, 14, 136-137.

Taylor, S. C. The keyword mnemonic method for teaching vocabulary. It's use by learning disabled children with memory difficulties. (Doctoral dissertation, Oklahoma State University, Stillwater, May, 1980.)

Thomas, H. Preferences for random shapes: ages six through nineteen. Child Development, 1966, 37, 843-859.

Tomasulo, D. Functional attributes of mediational imagery: A developmental view toward habilitation of retarded adults. In J. E. Shorr, G. E. Sobel, P. Robin & J. A. Connella (Eds.), Imagery. It's many dimensions and applications. New York: Plenum Press, 1980.

Torgeson, J. K. Memorization processes in reading-disabled children. Journal of Educational Psychology, 1977, 69, 571-578.

Van de Voort, L., Senf, G. M., & Benton, A. L. Development of audio-visual integration in normal and retarded readers. Child Development, 1972, 43, 1260-1272.

Van der Veur, B. Imagery rating of 1,000 frequently used words. Journal of Educational Psychology, 1975, 67, 44-56.

Vander Zanden, J. W. Educational psychology in theory and practice. New York: Random House, 1980.

Wadsworth, B. J. Piaget's theory of cognitive development (2nd ed.). New York: Longman, Inc., 1979.

Weber, R. J., & Castleman, J. The time it takes to imagine. Perception and Psychophysics, 1970, 8, 165-168.

Weber, R. J., & Harnish, R. Visual imagery for words: The Hebb test. Journal of Experimental Psychology, 1974, 102, 409-414.

Weber, R. J., Hochhaus, L., & Brown, W. D. Equivalence of perceptual and imaginal representation: Developmental changes. In J. Long & A. Baddeley (Eds.), Attention and performance IX. Hillsdale, N. J.: Lawrence Erlbaum Associates, 1981.

Weber, R. J., Kelly, J., & Little, S. Is visual image sequencing under verbal control? Journal of Experimental Psychology, 1972, 96, 354-362.

Weber, R. J., & McManman, K. Visual representation of words in perceptual and image modes as a function of age. Bulletin of the Psychonomic Society, 1977, 9, 33-36.

Williams, J. R., Blumberg, E. L., & Williams, D. V. Cues used in visual word recognition. Journal of Educational Psychology, 1970, 61, 310-315.

Yuille, J. C., & Catchpole, M. J. The role of imagery in models of cognition. Journal of Mental Imagery, 1977, 1, 171-180.

APPENDIX A

PERMISSION FORM

February 9, 1982

Dear Parent:

I'm a graduate student at Oklahoma State University and I'm working on developing some new methods that may make it easier for children to learn to read. I would like to have your permission to have your son/daughter participate in my study. It will take 15 - 30 minutes of your child's time. I will come to the school to work with your child. Individual children will not be compared against each other. The results will be strictly anonymous and will not be associated in any way with your child's name.

Please sign the form at the bottom of the page and have your child return it to his teacher as soon as possible. If you have any questions regarding this research project, please contact your child's school principal. Thank you for your cooperation.

Sincerely,

Marcella Sweet

Marcella Sweet
Doctoral Candidate, Applied Behavioral Studies in Education
Oklahoma State University

I hereby give my permission for my son/daughter, ______________, to participate in the research project described above.

______________ Date

______________ Parent's Signature

APPENDIX B

MATERIALS USED IN EXPERIMENT

Demonstration Cards

"Up" letters	d f t
"Down" letters	g j p
"Flat" letters	a c m

Alphabet Card

i	d	m	p	a	h	t	g	l	v	q	e
f	o	j	n	b	z	r	w	k	c	x	u
y	s										

Name: ______________________

Date: ______________________
(year) (month) (day)

DOB: ______________________

Age: ______________________

Sex: ___M ___F

Mode of Presentation: ___P ___I ___M

Race: ___ Caucasian
___ Negro
___ Indian
___ Spanish American
___ Oriental
___ Other ______________

Grade & Teacher: ______________

School: ______________

Identifying Code: __________

RESPONSE RECORD SHEET

List I

	Correctly Read	Word	Response	Time (sec.)	Recalled
Ex.	___ ___ ___	farm	____	_____	____
	___ ___ ___	game	____	_____	____
	___ ___ ___	well	____	_____	____
	___ ___ ___	goat	____	_____	____
	___ ___ ___	gone	____	_____	____
	___ ___ ___	help	____	_____	____
	___ ___ ___	jump	____	_____	____
	___ ___ ___	look	____	_____	____
	___ ___ ___	next	____	_____	____
	___ ___ ___	race	____	_____	____
	___ ___ ___	sing	____	_____	____
	___ ___ ___	take	____	_____	____

Time for recall:

____
(sec)

Name: ______________________ Date: ____________________

RESPONSE RECORD SHEET

List II

	Correctly Read	Word	Response	Time (sec.)	Recalled
Ex.	___ ___ ___	barm	_____	_______	_____
	___ ___ ___	pame	_____	_______	_____
	___ ___ ___	zell	_____	_______	_____
	___ ___ ___	belp	_____	_______	_____
	___ ___ ___	dake	_____	_______	_____
	___ ___ ___	dook	_____	_______	_____
	___ ___ ___	gump	_____	_______	_____
	___ ___ ___	nace	_____	_______	_____
	___ ___ ___	poat	_____	_______	_____
	___ ___ ___	ving	_____	_______	_____
	___ ___ ___	wext	_____	_______	_____
	___ ___ ___	yone	_____	_______	_____

Time for recall:

____
(sec)

Name: ____________________

Date: ____________________

1. ____________	1. ____________
2. ____________	2. ____________
3. ____________	3. ____________
4. ____________	4. ____________
5. ____________	5. ____________
6. ____________	6. ____________
7. ____________	7. ____________
8. ____________	8. ____________
9. ____________	9. ____________

Breakdown of Words by Height of First and Last Letters and Consonant-Vowel-Consonant Phoneme Pattern (u = up, d = down, f = flat)

High Frequency Words			Pseudowords		
Height	Word	CVC	Height	Word	CVC
uf	farm	CVCC	uf	barm	CVCC
df	game	CVCE̸	df	pame	CVCE̸
fu	well	CVC	fu	zell	CVC
du	goat	CVC	du	poat	CVC
df	gone	CVCE̸	df	yone	CVCE̸
ud	help	CVCC	ud	belp	CVCC
dd	jump	CVCC	dd	gump	CVCC
uu	look	CVC	uu	dook	CVC
fu	next	CVCC	fu	wext	CVCC
ff	race	CVCE̸	ff	nace	CVCE̸
fd	sing	CVC	fd	ving	CVC
uf	take	CVCE̸	uf	dake	CVCE̸

APPENDIX C

INSTRUCTIONS USED IN EXPERIMENT

Training Instructions

I'm studying ways in which children (young people) look at words they remember. One way of remembering words is by paying attention to the height of the letters making up the word.

When we look at heights of small or lowercase letters, we may notice that the letter has a stem that points up like d, f and t. (Show demonstration card.) The letter may have a stem that points down and would fall below the line when printed on notebook paper like g, j and p. (Show demonstration card.) The letter may have no stem at all. What we mean by that is that when printed on notebook paper, these letters just sit on the line like a, c and m. (Show demonstration card.)

Let's look at some letters and classify them by height. If the letter has a stem that points up way above the line on notebook paper, you say, "Up." If the letter has a stem that points down and falls below the line when printed on notebook paper, you say, "Down." And if the letter just sits on the line when printed on notebook paper; it doesn't go way above the line or fall below the line, you say, "Flat." What do you think we'd call this letter? (Show alphabet card; go over each letter.)

Re: Misclassified Letters

Try to help the youngster look at his reasoning for his choice and help him work out the correct response.

e.g., Do you know why it's ________?
Does part of it fall below the line when printed on notebook paper, go way above the line or just sit on the line?
If it ______________________, we'll call it _________.

Upon completion of all letters, review the letters the child missed.

e.g., What will you call this again?
When you see a(n) ____, you'll call it ________.
Let's go over some of these letters again to help us remember what to call them when we see them again.
Let's look at some trouble spots again.

Instructions for Percept Mode

List I Examples

Reading of Word List

Read these words for me. (Show subject index cards on which the words are printed in lowercase letters.) Good. (Note: can go over mispronounced words up to 3 times for accuracy.)

Processing of Words

We're going to work with these words again. When I show you a word, you tell me how to spell the word by height of letter. For example, let's look at this word, farm. You would say, "up, flat, flat, flat." Okay? Now you try these. Ready? (Have subject go through all three examples. To time each response, start stopwatch when card is presented and stop it when subject has completed his response.)

Re: Errors in processing. Help correct any errors made on examples,

e.g., There's something not quite right with that one. Do you know what it is?
Do you see anything wrong with that one?
Look at (a particular letter) again. Is ____ an up, down or flat letter?

If the child cannot self-correct with the above cues, go over the heights of the letters again and even use the alphabet card to demonstrate the letter(s) of interest.

Recall of Words

How many of these words do you remember? Say them for me. (Keep response time.) Note: If no response is made within 20 seconds of instructions or prior incomplete recall, make inquiry,

e.g., Do you remember anymore?
Did it go away?

and provide reassurance.

e.g., That's okay.
That's hard to do isn't it?

List I Words

Reading of Word List

Now, read these words for me. (Note: can go over mispronounced words up to 3 times for accuracy.)

Processing of Words

We're going to work with these words again. When I show you a word, I want you to tell me how to spell the word by height of letter just like you did a little while ago. Just take your time and try to get these right. If you make a mistake and catch it, it's all right to correct yourself. Ready? (Have subject go through all the words; time each response as instructed on the examples.)

Re: Errors in processing. Help correct the first two words incorrectly processed in the same fashion used on errors on the example words. In addition, reinforce the first correct response following an incorrect one, e.g., Good!

Recall of Words

I want to see how many of these words you can remember. You'll have 2 minutes to say as many as you can. Go ahead. (Start stopwatch.)

Re: Attempts to cease task before completed. If child attempts to stop working on the task before the time limit has expired, encourage him to keep working,

e.g., Would you like to think about it anymore?

If the child says, "No," the investigator is to say, "Okay," and record the seconds used.

Provide reassurance to all subjects upon completion of this task,

e.g., Good!
That's hard to do isn't it?

Spelling of Words

Give the child a pencil and the folded response form for the spelling task. Ask the child to write his name on the paper. Then proceed with the following instructions:

> I'm going to give you a spelling test over these words you've just worked with. This will be regular spelling. Listen carefully. I can only say each word once. Are you ready? The first word is ___________. (Use stop-watch and let it run throughout the task. If the subject hasn't begun a word within 20 seconds after dictation, make inquiry and dictate the next word, e.g., Can you think how to spell that word? Well, let's go on. Ready? ________)

List II Examples

Reading of Word List

We're going to look at some more words. But this time we're not going to look at real words, we're going to look at nonsense words. How would you say this word? (Note: can go over mispronounced words up to 3 times for accuracy.)

Processing of Words

We're going to do what you did with the real words. When I show you a word, I want you to tell me how to spell the word by height of letter just like you did before.

Note:

Young children and older students who had a lot of difficulty on List I, add a reminder about heights of letters, e.g., Remember: If the letter has a stem that goes way above the line when printed on notebook paper, you say, "Up." If the letter has a stem that falls below the line when printed on notebook paper, you say, "Down." And if the letter just sits on the line when printed on notebook paper and doesn't really go anywhere, you say, "Flat."

Older students who missed only one letter on List I, remind them of height of that letter, e.g., What will you call a(n) ____ when you see it again?

Older students who made no errors on List I, provide no reminder of heights of letters.

Ready? (Have subject go through all examples; time responses as before.)

Re: Errors in processing. Help correct any errors made on examples following the same methods used in correcting errors previously.

Recall of Words

How many of these nonsense words do you remember? Say them for me. (Keep response time.) Note: If no response is made within 20 seconds of instructions or prior incomplete recall, make inquiry and provide reassurance as in the List I example instructions.

List II Words

Reading of Word List

Now, read these nonsense words for me. (Note: can go over mispronounced words up to 3 times for accuracy.)

Processing of Words

We're going to work with these words again. When I show you a word, I want you to tell me how to spell the word by height of letter just like you've been doing. Okay? Ready? (Have subject go through all the words; time each response.) Note: Do not correct errors on this list but do reinforce the first correct response following an incorrect one, e.g., Good!

Recall of Words

I want to see how many of these nonsense words you can remember. You'll have 2 minutes to say as many as you can. Go ahead. (Start stopwatch.) Note: If a subject tries to give up before his time limit is up, provide encouragement as on List I. Also, upon completion of the task, provide reassurance to all subjects.

Spelling of Words

Give the child a pencil and the folded response form for the spelling task with the second set of response blanks exposed. Then proceed with the following instructions:

> I'm going to give you a spelling test over these nonsense words. Again, this will be regular spelling. Listen carefully. I can only say each word once. Are you ready? The first word is ____________. (Use stopwatch and let it run throughout the task. If subject hasn't begun a word within 20 seconds after dictation, make inquiry as before and continue on with the next word.)

Instructions for Image Mode

List I Examples

Reading of Word List

Read these words words for me. (Show subject index cards on which the words are printed in lowercase letters.) Good. (Note: can go over mispronounced words up to 3 times for accuracy.)

Processing of Words

We're going to work with these letters again. I will say a word. Then I want you to imagine the letters of the word as if it's printed right in front of you and spell it to me by height of letter. For example, if I say the word, farm, you try to imagine the letters making up the word, farm. Then you would say, "up, flat, flat, flat." Okay? Now you try these. Ready? (Have subject go through all three examples. To time each response, start stopwatch as word is presented and stop it when subject has completed his response.)

Re: Errors in processing. Help correct any errors made on examples,

e.g., There's something not quite right with that one. Do you know what it is?
Do you see anything wrong with that one?
Think about (a particular letter) again. Is ____ an up, down or flat letter?

If the child cannot self-correct with the above cues, go over the heights of the letters again and even use the alphabet card to demonstrate the letter(s) of interest.

Recall of Words

How many of these words do you remember? Say them for me. (Keep response time.) Note: If no response is made within 20 seconds of instructions or prior incomplete recall, make inquiry,

e.g., Do you remember anymore?
Did it go away?

and provide reassurance,

e.g., That's okay.
That's hard to do isn't it?

List I Words

Reading of Word List

Now, read these words for me. (Note: can go over mispronounced words up to 3 times for accuracy.)

Processing of Words

We're going to work with these words again. When I say a word, I want you to imagine the letters of the word as if it's printed right in front of you and spell it to me by height of letter just like you did a little while ago. Just take your time and try to imagine what these words would look like if printed in small or lowercase letters just like you'd usually see them printed on a page in a book. If you make a mistake and catch it, it's all right to correct yourself. Ready? (Have subject go through all the words; time each response as instructed on the examples.)

Re: Errors in processing. Help correct the first two words incorrectly processed in the same fashion used on errors on the example words. In addition, reinforce the first correct response following an incorrect one, e.g., Good!

Recall of Words

I want to see how many of these words you can remember. You'll have 2 minutes to say as many as you can. Go ahead. (Start stopwatch.)

Re: Attempts to cease task before completed. If child attempts to stop working on the task before the time limit has expired, encourage him to keep working,

e.g., Would you like to think about it anymore?

If the child says, "No," the investigator is to say, "Okay," and record the seconds used.

Provide reassurance to all subjects upon completion of this task,

e.g., Good!
That's hard to do isn't it?

Spelling of Words

Give the child a pencil and the folded response form for the spelling task. Ask the child to write his name on the paper. Then proceed with the following instructions:

> I'm going to give you a spelling test over these words you've just worked with. This will be regular spelling. Listen carefully. I can only say each word once. Are you ready? The first word is __________. (Use stop-watch and let it run throughout the task. If the subject hasn't begun a word within 20 seconds after dictation, make inquiry and dictate the next word, e.g., Can you think how to spell that word? Well, let's go on. Ready? ________)

List II Examples

Reading of Word List

We're going to look at some more words. But this time we're not going to look at real words, we're going to look at nonsense words. How would you say this word? (Note: can go over mispronounced words up to 3 times for accuracy.)

Processing of Words

We're going to do what you did with the real words. When I tell you a word, I want you to imagine the letters of the word as if it's printed right in front of you and then spell the word to me by height of letter just like you did before.

> Note:
>
> Young children and older students who had a lot of difficulty on List I, add a reminder about heights of letters, e.g., Remember: If the letter has a stem that goes way above the line when printed on notebook paper, you say, "Up." If the letter has a stem that falls below the line when printed on notebook paper, you say, "Down." And if the letter just sits on the line when printed on notebook paper and doesn't really go anywhere, you say, "Flat."
>
> Older students who missed only one letter on List I, remind them of height of that letter, e.g., What will you call a(n) _____ when you see it again?
>
> Older students who made no errors on List I, provide no reminder of heights of letters.

Ready? (Have subject go through all examples; time responses as before.)

Re: Errors in processing. Help correct any errors made on examples following the same methods used in correcting errors on List I examples.

Recall of Words

How many of these nonsense words do you remember? Say them for me. (Keep response time.) Note: If no response is made within 20 seconds of instructions or prior incomplete recall, make inquiry and provide reassurance as in the List I example instructions.

List II Words

Reading of Word List

Now, read these nonsense words for me. (Note: can go over mispronounced words up to 3 times for accuracy.)

Processing of Words

We're going to work with these words again. When I say a word, I want you to imagine the letters of the word as if it's printed right in front of you and then spell the word to me by height of letter just like you've been doing. Okay? Ready? (Have subject go through all the words; time each response.) Note: Do not correct errors on this list but do reinforce the first correct response following an incorrect one, e.g., Good!

Recall of Words

I want to see how many of these nonsense words you can remember. You'll have 2 minutes to say as many as you can. Go ahead. (Start stopwatch.) Note: If a subject tries to give up before his time limit is up, provide encouragement as on List I. Also, upon completion of the task, provide reassurance to all subjects.

Spelling of Words

Give the child a pencil and the folded response form for the spelling task with the second set of response blanks exposed. Then proceed with the following instructions:

> I'm going to give you a spelling test over these nonsense words. Again, this will be regular spelling. Listen carefully. I can only say each word once. Are you ready? The

first word is ________. (Use stopwatch and let it run throughout the task. If subject hasn't begun a word within 20 seconds after dictation, make inquiry as before and continue on with the next word.)

Instructions for Mixed Mode

List I Examples

Reading of Word List

Read these words for me. (Show subject index cards on which the words are printed in capital letters.) Good. (Note: can go over mispronounced words up to 3 times for accuracy.)

Processing of Words

These words are printed in all capital letters aren't they? We're going to work with these words again. I will show you a word and I want you to imagine what it would look like printed in small or lowercase letters. Then I want you to spell the word to me by height of letter. For example, for the word, FARM, you would imagine what the word looks like printed in small letters and then you would say, "up, flat, flat, flat." Okay? Now, you try these. Ready? (Have subject go through all three examples. To time each response, start stopwatch when card is presented and stop it when subject has completed his response.)

Re: Errors in processing. Help correct any errors made on examples,

e.g., There's something not quite right with that one. Do you know what it is?
Do you see anything wrong with that one?
Think about (a particular letter) again. Is ____ an up, down or flat letter?

If the child cannot self-correct with the above cues, go over the heights of the letters again and even use the alphabet card to demonstrate the letter(s) of interest.

Recall of Words

How many of these words do you remember? Say them for me. (Keep response time.) Note: If no response is made within 20 seconds of instructions or prior incomplete recall, make inquiry,

e.g., Do you remember anymore?
Did it go away?

and provide reassurance,

e.g., That's okay, That's hard to do isn't it?, etc.

List I Words

Reading of Word List

Now, read these words for me. (Note: can go over mispronounced words up to 3 times for accuracy.)

Processing of Words

We're going to work with these words again. When I show you a word, I want you to try to imagine what it would look like printed in small or lowercase letters and then spell it to me by height of letter just like you did a little while ago. Just take your time and try to imagine what these words would look like when printed in small letters like you'd usually see them printed on a page in a book. If you make a mistake and catch it, it's all right to correct yourself. Ready? (Have subject go through all the words; time each response as instructed on examples.)

Re: Errors in processing. Help correct the first two words incorrectly processed in the same fashion used on errors on the example words. In addition, reinforce the first correct response following an incorrect one, e.g., Good!

Recall of Words

I want to see how many of these words you can remember. You'll have 2 minutes to say as many as you can. Go ahead. (Start stopwatch.)

Re: Attempts to cease task before completed. If child attempts to stop working on the task before the time limit has expired, encourage him to keep working,

e.g., Would you like to think about it anymore?

If the child says, "No," the investigator is to say, "Okay," and record the seconds used.

Provide reassurance to all subjects upon completion of this task,

e.g., Good!
That's hard to do isn't it?

Spelling of Words

Give the child a pencil and the folded response form for the spelling task. Ask the child to write his name on the paper. Then proceed with the following instructions:

> I'm going to give you a spelling test over these words you've just worked with. This will be regular spelling. Listen carefully. I can only say each word once. Are you ready? The first word is ________. (Use stop-watch and let it run throughout the task. If the subject hasn't begun a word within 20 seconds after dictation, make inquiry and dictate the next word, e.g., Can you think how to spell that word? Well, let's go on. Ready? ________)

List II Examples

Reading of Word List

We're going to look at some more words. But this time we're not going to look at real words, we're going to look at nonsense words. How would you say this word? (Note: can go over mispronounced words up to 3 times for accuracy.)

Processing of Words

We're going to do what you did with the real words. When I show you a word, I want you to imagine what it would look like printed in small or lowercase letters and then spell it to me by height of letter just like you did before.

> Note:
>
> Young children and older students who had a lot of difficulty on List I, add a reminder about heights of letters, e.g., Remember: If the letter has a stem that goes way above the line when printed on notebook paper, you say, "Up." If the letter has a stem that falls below the line when printed on notebook paper, you say, "Down." And if the letter just sits on the line when printed on notebook paper and doesn't really go anywhere, you say, "Flat."
>
> Older students who missed only one letter on List I, remind them of height of that letter, e.g., What will you call a(n) _____ when you see it again?
>
> Older students who made no errors on List I, provide no reminder of heights of letters.

Ready? (Have subject go through all examples; time responses as before.)

Re: Errors in processing. Help correct any errors made on examples following the same methods used in correcting errors on List I examples.

Recall of Words

How many of these nonsense words do you remember? Say them for me. (Keep response time.) Note: If no response is made within 20 seconds of instructions or prior incomplete recall, make inquiry and provide reassurance as on the List I example instructions.

List II Words

Reading of Word List

Now, read these nonsense words for me. (Note: can go over mispronounced words up to 3 times for accuracy.)

Processing of Words

We're going to work with these words again. When I show you a word, I want you to imagine what it would look like printed in small or lowercase letters and then spell it to me by height of letter just like you've been doing. Okay? Ready? (Have subject go through all the words; time each response.) Note: Do not correct errors on this list but do reinforce the first correct response following an incorrect one, e.g., Good!

Recall of Words

I want to see how many of these nonsense words you can remember. You'll have 2 minutes to say as many as you can. Go ahead. (Start stopwatch.) Note: If a subject tries to give up before his time limit is up, provide encouragement as on List I. Also, upon completion of the task, provide reassurance to all subjects.

Spelling of Words

Give the child a pencil and the folded response form for the spelling task with the second set of response blanks exposed. Then proceed with the following instructions:

> I'm going to give you a spelling test over these nonsense words. Again, this will be regular spelling. Listen carefully. I can only say each word once. Are you ready? The

first word is ___________. (Use stopwatch and let it run throughout the task. If subject hasn't begun a word within 20 seconds after dictation, make inquiry as before and continue on with the next word.)

Concluding Comments

(Child's name), thank you. You did a good job helping me learn more about how children (young people) look at and remember words.

I will be doing these things with other children (young people) here at your school. Since I want to find out how different children (young people) look at and remember words, it is important that you do not tell much about what we've done. If anyone asks what we did, you may say, "I looked at some words." Please say no more. Okay?

APPENDIX D

ADDITIONAL DATA ON CORRECT RESPONSE TIME

TABLE XVII

SIMPLE EFFECTS BREAKDOWN FOR ABILITY (A) BY AGE (C) INTERACTION FOR THE DEPENDENT VARIABLE OF INCORRECT RESPONSE TIME

Source	SS	df	MS	F
A at c_1	74.31	1	74.31	28.69**
A at c_2	5.95	1	5.95	2.31
C at a_1	63.85	1	63.85	24.65**
C at a_2	200.85	1	200.85	77.55**
Subj. w. Groups	217.79	84	2.59	

** $p < .01$

TABLE XVIII

MEAN INCORRECT RESPONSE TIME FOR THE ABILITY (A) BY AGE (C) INTERACTION

	9 year olds	14 year olds
High Ability	5.15	3.52
Low Ability	6.91	4.02

APPENDIX E

STRENGTH OF ASSOCIATION (η^2) VALUES

TABLE XIX

ETA SQUARED (η^2) VALUES FOR SIGNIFICANT MAIN EFFECTS AND INTERACTIONS OF CORRECT RESPONSES

Source	η^2
Response Time	
A (Ability)	6.6%
C (Age)	26.6%
D (Mode)	29.9%
A x C	2.1%
C x D	4.4%
B x D	.5%
A x B x D	.5%
Recall	
C (Age)	8.7%
D (Mode)	5.9%
F (Word Type)	5.2%
A x C	4.1%
F x D	3.0%
Spelling	
A (Ability)	6.3%
C (Age)	11.0%
G (Word Type)	21.6%
A x G	1.1%
G x C	1.2%

TABLE XX

ETA SQUARED (η^2) VALUES FOR SIGNIFICANT MAIN EFFECTS AND INTERACTIONS OF INCORRECT RESPONSES

Source	η^2
Response Time	
A (Ability)	8.7%
C (Age)	7.9%
D (Mode)	16.4%
A x C	4.6%
A x D	4.2%
C x D	8.9%
Recall	
A x F	2.2%
Spelling	
A (Ability)	6.1%
C (Age)	11.3%
G (Word Type)	21.3%
A x G	1.0%
G x C	1.3%

APPENDIX F

DATA ON INCORRECT RESPONSE TIME

TABLE XXI

SUMMARY TABLE FOR THE ANALYSIS OF VARIANCE
FOR THE DEPENDENT VARIABLE OF
INCORRECT RESPONSE TIME

Source	SS	df	MS	F	p
Between Subjects	3426.1307	95			
A (Ability)	372.7167	1	372.727	26.37	.0001
C (Age)	339.2831	1	339.283	24.01	.0001
D (Mode)	702.1675	2	351.084	24.84	.0001
A x C	195.9602	1	195.960	13.87	.0004
A x D	181.6135	2	90.807	6.43	.0025
C x D	381.7830	2	190.892	13.51	.0001
A x C x D	65.5020	2	32.751	2.32	
Subj. w. Groups	1187.1047	84	14.132		
Within Subjects	866.9728	96			
B (Word Type)	.9478	1	.948	.11	
A x B	11.1313	1	11.131	1.24	
B x C	12.2463	1	12.246	1.36	
B x D	39.5626	2	19.781	2.20	
A x B x C	.2035	1	.204	.02	
A x B x D	8.1160	2	4.058	.45	
B x C x D	18.8766	2	9.438	1.05	
A x B x C x D	20.2772	2	10.139	1.13	
B x Subj. w. Groups	755.6115	84	8.995		
Total	4293.1035	191			

TABLE XXII

SIMPLE EFFECTS BREAKDOWN FOR ABILITY (A) BY AGE (C) INTERACTION FOR THE DEPENDENT VARIABLE OF INCORRECT RESPONSE TIME

Source	SS	df	MS	F
A at c_1	554.593	1	554.93	30.249**
A at c_2	14.084	1	14.08	.996
C at a_1	9.773	1	9.77	.691
C at a_2	525.470	1	525.47	37.188**
Subj. w. Groups	1187.105	84		

** $p < .01$

TABLE XXIII

MEAN RESPONSE TIME OF INCORRECT RESPONSES FOR ABILITY (A) BY AGE (C) INTERACTION

	9 year olds	14 year olds
High Ability	1.867	1.271
Low Ability	6.716	2.037

TABLE XXIV

SIMPLE EFFECTS BREAKDOWN FOR ABILITY (A) BY MODE OF REPRESENTATION (D) INTERACTION FOR THE DEPENDENT VARIABLE OF INCORRECT RESPONSE TIME

Source	SS	df	MS	F
A at d_1	2.157	1	2.16	.153
A at d_2	421.071	1	421.07	29.800**
A at d_3	131.103	1	131.10	9.278**
D at a_1	85.032	2	42.52	3.009
D at a_2	798.750	2	399.38	28.265**
Subj. w. Groups	1187.105	84	14.13	

** $p < .01$

TABLE XXV

MEAN RESPONSE TIME OF INCORRECT RESPONSES FOR ABILITY (A) BY MODE OF REPRESENTATION (D) INTERACTION

	Percept	Image	Mixed
High Ability	.375	2.668	1.729
Low Ability	.742	7.798	4.589

TABLE XXVI

MEAN RESPONSE TIME OF INCORRECT RESPONSES AND TUKEY'S HSD POST HOC COMPARISONS FOR MAIN EFFECTS OF MODE OF REPRESENTATION IN LOW ABILITY STUDENTS

	Image	Mixed	Percept
	7.798	4.589	.742
Image		3.209**	7.056**
Mixed			3.847**
Percept			

** $p < .01$
Critical Difference: .01 = 2.844

TABLE XXVII

SIMPLE EFFECTS BREAKDOWN FOR AGE (C) BY MODE OF REPRESENTATION (D) INTERACTION FOR THE DEPENDENT VARIABLE OF INCORRECT RESPONSE TIME

Source	SS	df	MS	F
C at d_1	.610	1	.61	.043
C at d_2	698.413	1	698.41	49.427**
C at d_3	22.043	1	22.04	1.560
D at c_1	1009.065	2	504.53	35.706**
D at c_2	74.885	2	37.44	2.650
Subj. w. Groups	1187.105	84	14.13	

** $p < .01$

TABLE XXVIII

MEAN RESPONSE TIME OF INCORRECT RESPONSES FOR AGE (C) BY MODE OF REPRESENTATION (D) INTERACTION

	Percept	Image	Mixed
9 year olds	.656	8.537	3.745
14 year olds	.461	1.930	2.571

TABLE XXIX

MEAN RESPONSE TIME OF INCORRECT RESPONSES AND TUKEY'S HSD POST HOC COMPARISONS FOR MAIN EFFECTS OF MODE OF REPRESENTATION BY 9 YEAR OLDS

	Image	Mixed	Percept
	8.537	3.792	.656
Image		4.792**	7.881**
Mixed			3.089**
Percept			

* $p < .05$
** $p < .01$
Critical Differences: .05 = 2.259
.01 = 2.844

APPENDIX G

ADDITIONAL DATA ON CORRECT RECALL

TABLE XXX

SIMPLE EFFECTS BREAKDOWN FOR ABILITY (A) BY AGE (C) INTERACTION FOR THE DEPENDENT VARIABLE OF CORRECT RECALL

Source	SS	df	MS	F
A at c_1	2.042	1	2.04	.723
A at c_2	27.094	1	27.09	9.606**
C at a_1	66.667	1	66.67	23.642**
C at a_2	2.344	1	2.34	.830
Subj. w. Groups	236.438	84	2.82	

** $p < .01$

TABLE XXXI

MEAN NUMBER OF WORDS CORRECTLY RECALLED FOR THE ABILITY (A) BY AGE (C) INTERACTION

	9 year olds	14 year olds
High Ability	2.771	4.438
Low Ability	3.063	3.375

APPENDIX H

DATA ON INCORRECT RECALL

TABLE XXXII

SUMMARY TABLE FOR THE ANALYSIS OF VARIANCE FOR THE DEPENDENT VARIABLE OF INCORRECT RECALL

Source	SS	df	MS	F	p
Between Subjects	141.8124	95			
A (Ability)	1.0208	1	1.021	.64	
C (Age)	.1875	1	.188	.12	
D (Mode)	2.3750	2	1.188	.74	
A x C	.5208	1	.521	.33	
A x D	.6667	2	.334	.21	
C x D	.8750	2	.438	.27	
A x C x D	1.7916	2	.896	.56	
Subj. w. Groups	134.3750	84	1.560		
Within Subjects	136.0000	96			
F (Word Type)	3.0000	1	3.000	2.21	
A x F	6.7500	1	6.750	4.98	.0283
F x C	1.3333	1	1.333	.98	
F x D	2.6250	2	1.313	.97	
A x F x C	.0833	1	.083	.06	
A x F x D	3.1250	2	1.563	1.15	
F x C x D	4.0417	2	2.021	1.49	
A x F x C x D	1.1667	2	.583	.43	
F x Subj. w. Groups	113.8750	84	1.356		
Total	227.8124	191			

TABLE XXXIII

SIMPLE EFFECTS BREAKDOWN FOR ABILITY (A) BY WORD TYPE (F) INTERACTION FOR THE DEPENDENT VARIABLE OF INCORRECT RECALL

Source	SS	df	MS	F
A at f_1	1.260	1	1.26	.851
A at f_2	6.510	1	6.51	4.399*
F at a_1	.375	1	.38	.257
F at a_2	9.374	1	9.37	6.331*
Pooled Error		168	1.48	

* $p < .05$

TABLE XXXIV

MEAN NUMBER OF WORDS INCORRECTLY RECALLED FOR ABILITY (A) BY WORD TYPE (F) INTERACTION

	High Frequency Words	Pseudowords
High Ability	1.021	.896
Low Ability	.792	1.417

APPENDIX I

ADDITIONAL DATA FOR CORRECT SPELLING

TABLE XXXV

SIMPLE EFFECTS BREAKDOWN FOR ABILITY (A) BY WORD TYPE (G) INTERACTION FOR THE DEPENDENT VARIABLE OF CORRECT SPELLING

Source	SS	df	MS	F
A at g_1	4.163	1	4.16	3.382
A at g_2	24.000	1	24.00	19.512**
G at a_1	25.011	1	25.01	20.333**
G at a_2	61.760	1	61.76	50.211**
Pooled Error		168	1.23	

** $p < .01$

TABLE XXXVI

MEAN NUMBER OF WORDS CORRECTLY SPELLED FOR ABILITY (A) BY WORD TYPE (G) INTERACTION

	High Frequency Words	Pseudowords
High Ability	8.875	7.854
Low Ability	8.458	6.854

TABLE XXXVII

SIMPLE EFFECTS BREAKDOWN FOR WORD TYPE (G) BY AGE (C) INTERACTION FOR THE DEPENDENT VARIABLE OF CORRECT SPELLING

Source	SS	df	MS	F
G at c_1	63.375	1	63.38	51.528**
G at c_2	24.000	1	24.00	19.512**
C at g_1	9.375	1	9.38	7.626**
C at g_2	37.500	1	37.50	30.488**
Pooled Error		168	1.23	

** $p < .01$

TABLE XXXVIII

MEAN NUMBER OF WORDS CORRECTLY SPELLED FOR WORD TYPE (G) BY AGE (C) INTERACTION

	High Frequency Words	Pseudowords
9 year olds	8.354	6.729
14 year olds	8.979	7.979

APPENDIX J

DATA ON INCORRECT SPELLING

TABLE XXXIX

SUMMARY TABLE FOR THE ANALYSIS OF VARIANCE
FOR THE DEPENDENT VARIABLE OF
INCORRECT SPELLING

Source	SS	df	MS	F	p
Between Subjects	227.4531	95			
A (Ability)	23.3802	1	23.380	13.29	.0005
C (Age)	43.1302	1	43.130	24.51	.0001
D (Mode)	4.5938	2	2.297	1.31	
A x C	4.3802	1	4.380	2.49	
A x D	.5104	2	.255	.15	
C x D	2.9479	2	1.474	.84	
A x C x D	.6979	2	.349	.20	
Subj. w. Groups	147.8125	84	1.760		
Within Subjects	155.5000	96			
G (Word Type)	81.3802	1	81.380	112.41	.0001
A x G	3.7969	1	3.797	5.24	.0245
G x C	5.0052	1	5.005	6.91	.0102
G x D	1.7604	2	.880	1.22	
A x G x C	.2552	1	.255	.35	
A x G x D	.5938	2	.297	.41	
G x C x D	1.0729	2	.536	.74	
A x G x C x D	.8229	2	.411	.57	
G x Subj. w. Groups	60.8125	84	.724		
Total	382.9531	191			

TABLE XL

SIMPLE EFFECTS BREAKDOWN FOR THE ABILITY (A) BY WORD TYPE (G) INTERACTION FOR THE DEPENDENT VARIABLE OF INCORRECT SPELLING

Source	SS	df	MS	F
A at g_1	4.166	1	4.17	3.363
A at g_2	24.000	1	24.00	19.355**
G at a_1	25.011	1	25.01	20.169**
G at a_2	61.760	1	61.76	49.806**
Pooled Error		168	1.24	

** $p < .01$

TABLE XLI

MEAN NUMBER OF WORDS INCORRECTLY SPELLED FOR ABILITY (A) BY WORD TYPE (G) INTERACTION

	High Frequency Words	Pseudowords
High Ability	.125	1.146
Low Ability	.542	2.146

TABLE XLII

SIMPLE EFFECTS BREAKDOWN FOR WORD TYPE (G) BY AGE (C) INTERACTION FOR THE DEPENDENT VARIABLE OF INCORRECT SPELLING

Source	SS	df	MS	F
G at c_1	63.375	1	63.38	51.113**
G at c_2	24.000	1	24.00	19.355**
C at g_1	9.375	1	9.38	7.565**
C at g_2	37.500	1	37.50	30.242**
Pooled Error		168	1.24	

** $p < .01$

TABLE XLIII

MEAN NUMBER OF WORDS INCORRECTLY SPELLED FOR WORD TYPE (G) BY AGE (C) INTERACTION

	High Frequency Words	Pseudowords
9 year olds	.646	2.271
14 year olds	.021	1.021

APPENDIX K

DESCRIPTIVE STATISTICS FOR CORRECT RESPONSES ON EXPERIMENTAL TASKS

Descriptive Statistics for Correct Responses

Descriptive statistics for correct responses on the experimental tasks were compiled by word type, age, ability and mode of representation. These statistics appear in Tables XLIV through XLIX.

With regard to words correctly processed by both age levels on both word lists (Tables XLIV and XLV), it can be seen that subjects in the imaginal condition took longer to process words than those in the percept group. In addition, it can also be seen that shorter time scores were accompanied by higher accuracy scores.

On the recall task, subjects of both age levels in the imaginal condition tended to recall more words on both lists that those in the percept condition (Tables XLVI and XLVII). Low ability nine year old subjects in the imaginal condition appeared to recall more words than their high ability peers; low ability subjects also took longer to process the words (Tables XLIV and XLV).

Data on words correctly spelled (Tables XLVIII and XLIX) indicates that both age levels spelled more high frequency words correctly than pseudowords; the data suggests a ceiling effect for fourteen year olds on the high frequency words. In addition, fourteen year olds spelled more words correctly on both lists than nine year olds.

TABLE XLIV

DESCRIPTIVE STATISTICS FOR THE NUMBER OF HIGH FREQUENCY WORDS (n = 9) CORRECTLY PROCESSED AND TIME FOR PROCESSING BY AGE, ABILITY AND MODE OF REPRESENTATION

	% words correctly processed	$\bar{X}$	SD	$\bar{X}$ time (sec.)	SD (sec.)
9 year olds					
High Ability (n = 8)					
Percept	100.00	9.00	.00	3.46	.42
Mixed	94.44	8.50	.71	5.27	.77
Image	93.06	8.38	.70	7.11	2.19
Low Ability (n = 8)					
Percept	97.22	8.75	.43	5.33	2.17
Mixed	77.78	7.00	1.94	7.02	1.08
Image	73.61	6.63	1.41	8.85	2.39
14 year olds					
High Ability (n = 8)					
Percept	97.22	8.75	.43	2.50	.74
Mixed	93.06	8.38	.70	3.80	.69
Image	100.00	9.00	.00	4.65	.53
Low Ability (n = 8)					
Percept	98.61	8.88	.33	3.25	.93
Mixed	76.39	6.88	2.62	4.35	1.15
Image	97.22	8.75	.43	4.46	.37

TABLE XLV

DESCRIPTIVE STATISTICS FOR THE NUMBER OF PSEUDOWORDS (n = 9) CORRECTLY PROCESSED AND TIME FOR PROCESSING BY AGE, ABILITY AND MODE OF REPRESENTATION

	% words correctly processed	$\bar{X}$	SD	$\bar{X}$ time (sec.)	SD (sec.)
9 year olds					
High Ability (n = 8)					
Percept	98.61	8.88	.33	3.31	.56
Mixed	100.00	9.00	.00	4.92	.69
Image	88.89	8.00	1.32	6.86	1.80
Low Ability (n = 8)					
Percept	98.61	8.88	.33	4.06	.47
Mixed	81.94	7.38	1.22	6.67	.72
Image	68.06	6.13	1.76	9.57	2.81
14 year olds					
High Ability (n = 8)					
Percept	100.00	9.00	.00	2.44	.61
Mixed	91.67	8.25	.82	3.36	.52
Image	94.44	8.50	.71	4.40	.63
Low Ability (n = 8)					
Percept	95.83	8.63	.48	3.25	1.22
Mixed	91.67	8.25	.82	3.64	.86
Image	86.11	7.75	.97	5.17	.77

TABLE XLVI

DESCRIPTIVE STATISTICS FOR WORDS CORRECTLY RECALLED ON HIGH FREQUENCY WORD LIST (n = 9)

	% words correctly recalled	$\bar{X}$	SD
9 year olds			
High Ability (n = 8)			
Percept	29.17	2.63	.92
Mixed	34.72	3.13	.99
Image	37.50	3.38	.92
Low Ability (n = 8)			
Percept	27.78	2.50	1.07
Mixed	41.67	3.75	1.39
Image	51.39	4.63	1.41
14 year olds			
High Ability (n = 8)			
Percept	47.22	4.25	1.04
Mixed	52.78	4.75	1.98
Image	59.72	5.38	1.30
Low Ability (n = 8)			
Percept	31.94	2.88	2.03
Mixed	36.11	3.25	.89
Image	55.56	5.00	1.60

TABLE XLVII

DESCRIPTIVE STATISTICS FOR WORDS CORRECTLY RECALLED ON PSEUDOWORD LIST (n = 9)

	% words correctly recalled	$\bar{X}$	SD
9 year olds			
High Ability (n = 8)			
Percept	31.94	2.88	2.10
Mixed	27.78	2.50	1.07
Image	23.61	2.13	1.55
Low Ability (n = 8)			
Percept	26.39	2.38	1.06
Mixed	20.83	1.88	.83
Image	36.11	3.25	1.49
14 year olds			
High Ability (n = 8)			
Percept	51.39	4.63	2.20
Mixed	34.72	3.13	1.46
Image	50.00	4.50	1.77
Low Ability (n = 8)			
Percept	29.17	2.63	1.51
Mixed	31.94	2.88	1.96
Image	40.28	3.63	1.88

TABLE XLVIII

DESCRIPTIVE STATISTICS FOR WORDS CORRECTLY SPELLED ON HIGH FREQUENCY WORD LIST
(n = 9)

	% words correctly spelled	$\bar{X}$	SD
9 year olds			
High Ability (n = 8)			
Percept	94.44	8.50	.76
Mixed	97.22	8.75	.46
Image	100.00	9.00	.00
Low Ability (n = 8)			
Percept	90.28	8.13	1.36
Mixed	84.72	7.63	1.77
Image	90.28	8.13	1.13
14 year olds			
High Ability (n = 8)			
Percept	100.00	9.00	.00
Mixed	100.00	9.00	.00
Image	100.00	9.00	.00
Low Ability (n = 8)			
Percept	100.00	9.00	.00
Mixed	98.61	8.88	.35
Image	100.00	9.00	.00

TABLE XLIX

DESCRIPTIVE STATISTICS FOR WORDS CORRECTLY SPELLED ON PSEUDOWORD LIST (n = 9)

	% words correctly spelled	$\bar{X}$	SD
9 year olds			
High Ability (n = 8)			
Percept	86.11	7.75	1.28
Mixed	76.39	6.88	.99
Image	81.94	7.38	1.92
Low Ability (n = 8)			
Percept	70.83	6.38	1.77
Mixed	59.72	5.38	1.60
Image	73.61	6.63	2.07
14 year olds			
High Ability (n = 8)			
Percept	94.44	8.50	.53
Mixed	91.67	8.25	.71
Image	93.06	8.38	.74
Low Ability (n = 8)			
Percept	86.11	7.75	.46
Mixed	83.33	7.50	1.31
Image	83.33	7.50	1.69

APPENDIX L

DESCRIPTIVE STATISTICS FOR INCORRECT

RESPONSES ON EXPERIMENTAL TASKS

Descriptive Statistics for Incorrect Responses

Descriptive statistics for incorrect responses on the experimental tasks were compiled by word type, age, ability and mode of representation. These statistics appear in Tables L through LV.

With regard to words incorrectly processed by both age levels on both word lists, it can be seen that longer time scores are also accompanied by higher error scores (Tables L and LI). Therefore, it can be concluded that there was no speed-accuracy trade off.

On the recall task, high ability subjects in each age group provided fewer incorrect responses on the pseudoword list than their low ability peers in each experimental condition (Table LIII). In addition, both nine and fourteen year old subjects in the imaginal condition recalled fewer incorrect responses than their peers in the percept condition following the pseudoword list.

Data on words incorrectly spelled (Tables LIV and LV) shows that subjects in both age levels spelled more pseudowords incorrectly than high frequency words. In addition, nine year olds spelled more words incorrectly than fourteen year olds.

TABLE L

DESCRIPTIVE STATISTICS FOR THE NUMBER OF HIGH FREQUENCY WORDS (n = 9) INCORRECTLY PROCESSED AND TIME FOR PROCESSING BY AGE, ABILITY AND MODE OF REPRESENTATION

	% words incorrectly processed	$\bar{X}$	SD	$\bar{X}$ time (sec.)	SD (sec.)
9 year olds					
High Ability (n = 8)					
Percept	.00	.00	.00	.00	.00
Mixed	5.56	.50	.50	2.20	3.62
Image	6.94	.63	.70	4.84	6.62
Low Ability (n = 8)					
Percept	2.78	.25	.43	1.63	3.11
Mixed	22.22	2.00	1.94	6.04	4.26
Image	26.39	2.38	1.41	12.21	7.64
14 year olds					
High Ability (n = 8)					
Percept	2.78	.25	.43	1.00	1.93
Mixed	6.94	.63	.70	2.47	3.01
Image	.00	.00	.00	.00	.00
Low Ability (n = 8)					
Percept	1.39	.13	.33	.25	.74
Mixed	23.61	2.13	2.62	3.21	2.85
Image	2.78	.25	.43	1.06	2.01

TABLE LI

DESCRIPTIVE STATISTICS FOR THE NUMBER OF PSEUDOWORDS (n = 9) INCORRECTLY PROCESSED AND TIME FOR PROCESSING BY AGE, ABILITY AND MODE OF REPRESENTATION

	% words incorrectly processed	$\bar{X}$	SD	$\bar{X}$ time (sec.)	SD (sec.)
9 year olds					
High Ability (n = 8)					
Percept	1.39	.13	.33	.50	1.41
Mixed	.00	.00	.00	.00	.00
Image	11.11	1.00	1.32	3.86	4.49
Low Ability (n = 8)					
Percept	1.39	.13	.33	.50	1.41
Mixed	18.06	1.63	1.22	6.69	4.90
Image	31.94	2.88	1.76	13.23	5.21
14 year olds					
High Ability (n = 8)					
Percept	.00	.00	.00	.00	.00
Mixed	8.33	.75	.83	2.19	2.45
Image	5.56	.50	.61	1.97	2.75
Low Ability (n = 8)					
Percept	4.17	.38	.70	.59	1.10
Mixed	8.33	.75	.83	2.42	2.64
Image	13.89	1.25	.97	4.69	3.48

TABLE LII

DESCRIPTIVE STATISTICS FOR WORDS INCORRECTLY RECALLED ON HIGH FREQUENCY WORD LIST (n = 9)

	% words incorrectly recalled	$\bar{X}$	SD
9 year olds			
High Ability (n = 8)			
Percept	12.50	1.13	1.13
Mixed	11.11	1.00	.76
Image	11.11	1.00	.76
Low Ability (n = 8)			
Percept	2.78	.25	.46
Mixed	5.56	.50	.76
Image	13.89	1.25	1.39
14 year olds			
High Ability (n = 8)			
Percept	8.33	.75	.89
Mixed	13.89	1.25	1.28
Image	11.11	1.00	1.31
Low Ability (n = 8)			
Percept	4.17	.38	.74
Mixed	12.50	1.13	.99
Image	13.89	1.25	1.28

TABLE LIII

DESCRIPTIVE STATISTICS FOR WORDS INCORRECTLY RECALLED ON PSEUDOWORD LIST (n = 9)

	% words incorrectly recalled	$\bar{X}$	SD
9 year olds			
High Ability (n = 8)			
Percept	12.50	1.13	1.46
Mixed	13.89	1.25	1.04
Image	8.33	.75	.71
Low Ability (n = 8)			
Percept	15.28	1.38	1.06
Mixed	22.22	2.00	2.67
Image	12.50	1.13	.99
14 year olds			
High Ability (n = 8)			
Percept	4.17	.38	.52
Mixed	9.72	.88	.83
Image	11.11	1.00	1.20
Low Ability (n = 8)			
Percept	18.06	1.63	1.60
Mixed	11.11	1.00	.93
Image	15.28	1.38	2.07

TABLE LIV

DESCRIPTIVE STATISTICS FOR WORDS INCORRECTLY SPELLED ON HIGH FREQUENCY WORD LIST
(n = 9)

	% words incorrectly spelled	$\bar{X}$	SD
9 year olds			
High Ability (n = 8)			
Percept	5.56	.50	.76
Mixed	2.78	.25	.46
Image	18.06	1.63	1.92
Low Ability (n = 8)			
Percept	9.72	.88	1.36
Mixed	15.28	1.38	1.77
Image	9.72	.88	1.13
14 year olds			
High Ability (n = 8)			
Percept	.00	.00	.00
Mixed	.00	.00	.00
Image	.00	.00	.00
Low Ability (n = 8)			
Percept	.00	.00	.00
Mixed	1.39	.13	.35
Image	.00	.00	.00

TABLE LV

DESCRIPTIVE STATISTICS FOR WORDS INCORRECTLY SPELLED ON PSEUDOWORD LIST (n = 9)

	% words incorrectly spelled	$\bar{X}$	SD
9 year olds			
High Ability (n = 8)			
Percept	13.89	1.25	1.28
Mixed	23.61	2.13	.99
Image	18.06	1.63	1.92
Low Ability (n = 8)			
Percept	29.17	2.63	1.77
Mixed	40.28	3.63	1.60
Image	26.39	2.38	2.07
14 year olds			
High Ability (n = 8)			
Percept	5.56	.50	.53
Mixed	8.33	.75	.71
Image	6.94	.63	.74
Low Ability (n = 8)			
Percept	13.89	1.25	.46
Mixed	15.28	1.38	1.41
Image	16.67	1.50	1.69

APPENDIX M

PEARSON CORRELATIONS FOR CORRECT RESPONSE SCORES ON EXPERIMENTAL TASKS AND READING TEST SCORES

Correlational Data for Correct Response Scores on Experimental Tasks and Gates-MacGinitie Scores

Pearson correlations were computed for each experimental task with Gates-MacGinitie raw scores as a function of age, word type and mode of representation. These correlations appear in Tables LVI through LXI.

As can be seen from Tables LVI and LVII, low processing times in the percept condition on high frequency words tend to correlate highly with high total reading scores on the Gates-MacGinitie for both age levels ($r = -.54$ and $-.60$). Therefore, it appears that good readers take less time to process familiar words.

With regard to the ability to recall words, there was a large increase in correlations for the percept condition between nine and fourteen year olds which indicates a tremendous increase in the ability to extract perceptual information between the ages of nine and fourteen (Tables LVIII and LX). In addition, larger correlations for nine year olds in the imaginal condition than perceptual condition suggests a depth of processing effect.

With regard to the ability to write words from dictation, it can be seen from Table LX that nine year olds in the imaginal condition who made high scores on the spelling test for high frequency words also made high scores on the Gates-MacGinitie Test ($r = .76$, $.58$ and $.69$). In addition, the larger correlations for the imaginal condition than percept condition suggests a depth of processing effect. The zero correlations for fourteen year olds on the high frequency word list (Table LX) indicates a ceiling effect, i.e., the words were too easy for the fourteen year olds. It can be further seen from Tables LX and LXI that high spelling scores on the pseudoword list correlate highly with Gates scores (.50 to .60) for both age levels in the percept condition.

TABLE LVI

PEARSON CORRELATIONS BETWEEN CORRECT RESPONSE TIME AND GATES-MACGINITIE SCORES: 9 YEAR OLDS

Experimental Task	Gates-MacGinitie Scores		
(Response Time)	Vocabulary	Comprehension	Total Reading
High Frequency Words			
Percept	-.61557*	-.43967	-.54315*
Mixed	-.31683	-.39249	-.37373
Image	-.39904	-.48607	-.46026
Pseudowords			
Percept	-.46437	-.38408	-.43842
Mixed	-.61051*	-.66721**	-.67398**
Image	-.48928	-.58761*	-.55990*

* $p < .05$
** $p < .01$

TABLE LVII

PEARSON CORRELATIONS BETWEEN CORRECT RESPONSE TIME AND GATES-MACGINITIE SCORES: 14 YEAR OLDS

Experimental Task	Gates-MacGinitie Scores		
(Response Time)	Vocabulary	Comprehension	Total Reading
High Frequency Words			
Percept	-.58870*	-.58422	-.59674*
Mixed	-.43540	-.39412	-.43458
Image	.21180	.17214	.20540
Pseudowords			
Percept	-.55648*	-.56818*	-.57113*
Mixed	.28275	-.45629	-.36112
Image	-.46067	-.25812	-.40357

* $p < .05$
** $p < .01$

TABLE LVIII

PEARSON CORRELATIONS BETWEEN CORRECT RECALL AND GATES-MACGINITIE SCORES: 9 YEAR OLDS

Experimental Task	Gates-MacGinitie Scores		
(Recall)	Vocabulary	Comprehension	Total Reading
High Frequency Words			
Percept	-.05941	-.23723	-.15903
Mixed	.04663	-.25299	-.10602
Image	-.40123	-.38044	-.40542
Pseudowords			
Percept	-.02490	.06513	.04788
Mixed	.21719	.23992	.24110
Image	-.26147	-.09628	-.18387

TABLE LIX

PEARSON CORRELATIONS BETWEEN CORRECT RECALL AND GATES-MACGINITIE SCORES: 14 YEAR OLDS

Experimental Task	Gates-MacGinitie Scores		
(Recall)	Vocabulary	Comprehension	Total Reading
High Frequency Words			
Percept	.61402*	.58034*	.60957*
Mixed	.39631	.40436	.41353
Image	.10412	.14014	.12159
Pseudowords			
Percept	.48012	.45944	.47914
Mixed	.30424	.33262	.32620
Image	.39451	.35538	.39550

* $p < .05$

TABLE LX

PEARSON CORRELATIONS BETWEEN CORRECT SPELLING AND GATES-MACGINITIE SCORES: 9 YEAR OLDS

Experimental Task (Spelling)	Gates-MacGinitie Scores Vocabulary	Comprehension	Total Reading
High Frequency Words			
Percept	.30318	.30749	.31729
Mixed	.63995**	.65363**	.68278**
Image	.75911**	.58169*	.69389**
Pseudowords			
Percept	.60535*	.50914*	.57615*
Mixed	.75129**	.75571**	.79554**
Image	.36860	.07791	.22858

* $p < .05$
** $p < .01$

TABLE LXI

PEARSON CORRELATIONS BETWEEN CORRECT SPELLING AND GATES-MACGINITIE SCORES: 14 YEAR OLDS

Experimental Task	Gates-MacGinitie Scores		
(Spelling)	Vocabulary	Comprehension	Total Reading
High Frequency Words			
Percept	.00000	.00000	.00000
Mixed	.31148	.15824	.26217
Image	.00000	.00000	.00000
Pseudowords			
Percept	.59584*	.53800*	.58040*
Mixed	.38948	.21319	.33386
Image	.27192	-.08833	.14883

* $p < .05$

APPENDIX N

PEARSON CORRELATIONS FOR INCORRECT RESPONSE

SCORES ON EXPERIMENTAL TASKS AND

READING TEST SCORES

Correlational Data for Incorrect Response Scores on Experimental Tasks and Gates-MacGinitie Scores

Pearson correlations were computed for each experimental task with Gates-MacGinitie raw scores as a function of age, word type and mode of representation. These correlations appear in Tables LXII through LXVII.

As can be seen from Table LXII, the more time nine year olds in the imaginal condition spent on making an error in processing words, the lower the Gates score ($r = -.57$ to $-.75$).

With regard to incorrect recall of pseudowords, the larger the number of errors, the lower the Gates scores tended to be for both age levels (Tables LXIV and LXV).

With regard to words incorrectly spelled, the more high frequency words incorrectly spelled by nine year olds in the imaginal condition (Table LXVI), the lower the Gates scores ($r = -.76$, $-.58$ and $-.69$). These correlations are identical in magnitude to those found on words correctly spelled; therefore, 47.6% of the variance in total reading scores appears to be related to spelling of words processed in the imaginal mode.

TABLE LXII

PEARSON CORRELATIONS BETWEEN INCORRECT RESPONSE TIME AND GATES-MACGINITIE SCORES: 9 YEAR OLDS

Experimental Task	Gates-MacGinitie Scores		
(Response Time)	Vocabulary	Comprehension	Total Reading
High Frequency Words			
Percept	-.10673	-.27578	-.20338
Mixed	-.40922	-.34562	-.39912
Image	-.57809*	-.59011*	-.60636*
Pseudowords			
Percept	.07739	.05096	.06593
Mixed	-.59507*	-.49458	-.57623*
Image	-.74523**	-.70095**	-.75001**

* $p < .05$
** $p < .01$

TABLE LXIII

PEARSON CORRELATIONS BETWEEN INCORRECT RESPONSE TIME AND GATES-MACGINITIE SCORES: 14 YEAR OLDS

Experimental Task (Response Time)	Gates-MacGinitie Scores Vocabulary	Comprehension	Total Reading
High Frequency Words			
Percept	.28614	.18966	.24833
Mixed	-.15721	-.17553	-.17000
Image	-.22706	-.20869	-.22917
Pseudowords			
Percept	-.19828	-.38612	-.28480
Mixed	-.12884	-.37569	-.23062
Image	-.42103	-.36510	-.41682

TABLE LXIV

PEARSON CORRELATIONS BETWEEN INCORRECT RECALL AND GATES-MACGINITIE SCORES: 9 YEAR OLDS

Experimental Task	Gates-MacGinitie Scores		
(Recall)	Vocabulary	Comprehension	Total Reading
High Frequency Words			
Percept	.16105	.31183	.24981
Mixed	.07780	.17298	.13147
Image	.00847	.09277	.05344
Pseudowords			
Percept	-.12808	.01789	.05316
Mixed	-.22042	-.26452	-.25558
Image	-.28233	-.18330	-.24057

TABLE LXV

PEARSON CORRELATIONS BETWEEN INCORRECT RECALL AND GATES-MACGINITIE SCORES: 14 YEAR OLDS

Experimental Task (Recall)	Gates-MacGinitie Scores Vocabulary	Comprehension	Total Reading
High Frequency Words			
Percept	.06029	.03174	.04869
Mixed	-.09592	-.12674	-.11145
Image	-.06089	.12074	.00417
Pseudowords			
Percept	-.26735	-.04676	-.17433
Mixed	-.17552	-.14538	-.16987
Image	-.19681	-.17108	-.19500

TABLE LXVI

PEARSON CORRELATIONS BETWEEN INCORRECT SPELLING AND GATES-MACGINITIE SCORES: 9 YEAR OLDS

Experimental Task (Spelling)	Gates-MacGinitie Scores Vocabulary	Comprehension	Total Reading
High Frequency Words			
Percept	-.30318	-.30749	-.31729
Mixed	-.63995**	-.65363**	-.68278**
Image	-.75911**	-.58169*	-.69389**
Pseudowords			
Percept	-.60535*	-.50914*	-.57615*
Mixed	-.75129**	-.75571**	-.79554**
Image	-.36860	-.07791	-.22858

* p<.05
** p<.01

TABLE LXVII

PEARSON CORRELATIONS BETWEEN INCORRECT SPELLING AND GATES-MACGINITIE SCORES: 14 YEAR OLDS

Experimental Task (Spelling)	Gates-MacGinitie Scores Vocabulary	Comprehension	Total Reading
High Frequency Words			
Percept	.00000	.00000	.00000
Mixed	-.31148	-.15824	-.26217
Image	.00000	.00000	.00000
Pseudowords			
Percept	-.59584*	-.53800*	-.58040*
Mixed	-.37931	-.18090	-.31462
Image	-.27192	.08833	-.14883

* $p < .05$

VITA

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Candidate for the Degree of

Doctor of Philosophy

Thesis: PERCEPT AND IMAGINAL REPRESENTATION OF WORDS AS RELATED TO THE READING PROCESS

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