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Developmental Changes in Verbal and Imaginal Mnemonic Techniques for Serial Recall

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Abstract

Children's ability to use mnemonic techniques was investigated in first, fourth and sixth graders. Children in each age group were assigned to one of three conditions: method of loci, story mnemonic or elaborative control group. Subjects were given three recall tests. Each test was scored with and without regard to the order in which subjects recalled the words presented. Relative to the control group, both mnemonic conditions showed an advantage in memorizing lists of 20 words. However, all conditions, including the elaborative control group showed significant increases in the number of words recalled between the baseline test and recall Test III. No significant differences were found between conditions when recall tests were scored without regard to order or by a strict positional criterion whereby subjects received credit for recalling a word only when it was placed in its correct position. A significant difference was found for the mnemonic method most effective at the different age levels studied. First graders scored significantly higher when using the story mnemonic whereas sixth graders scored highest when using the method of loci. Fourth graders were able to use both mnemonic techniques equally well. Both fourth and sixth graders scored significantly higher than the first grade subjects. No significant difference was found between the fourth and sixth grade levels in the number of

words recalled within each condition. It appears a developmental trend may be present whereby younger children are able to use linguistic mnemonics more effectively and older children utilize imagery based mnemonics most efficiently. A transitional stage present at the fourth grade level enables children at this age to use either type of mnemonic in an effective manner.

Chapter 1

Statement of the Problem

Since the times of the ancient Greeks, people have been searching for techniques to improve their memory. The word mnemonic means "aiding the memory," and the origin of mnemonics can be traced back to about 500 B.C. (Higbee, 1979). Thus, a mnemonic strategy is a system which aids the memory, and mnemonics refers to general methods of memory improvement. Many people in the area of mnemonics have come to believe Mandler's (1967) dictum that to organize is to memorize and to memorize is to organize. Thus, an effective way to memorize information is to organize it in some way that is meaningful to the individual attempting to retain the information. This is the key to many mnemonic techniques.

It has been demonstrated that training children in the use of mnemonic techniques can enhance children's learning (Rohwer, 1970). This being the case, mnemonics may prove to be of importance in tasks which require children to learn new information. However, acquisition and effectiveness of mnemonic techniques may be affected by a variety of factors. The present study compared two mnemonic strategies and how they are influenced by age differences of the subjects investigated.

Mature use of a mnemonic technique has been characterized as developing through three stages (Flavell, 1977). The first stage is referred to as a "mediational deficiency."

During this stage children are not able to utilize a mnemonic strategy effectively. During the second stage, children are capable of utilizing the strategy effectively if specifically instructed to do so, but do not spontaneously make use of the strategy. This is referred to as a "production deficiency." The third and final stage involves mature use of the mnemonic strategy. During this stage children spontaneously use the strategy when performing strategy-appropriate tasks.

When given a deliberate memorization task, children younger than seven years of age generally do not spontaneously use mnemonic strategies (Brown, 1975; Kramer, & Engle, 1981; Paris, Newman, & McVey, 1982). However, Carlson, Kincaid, Lance, and Hodgson (1976) found that college-age subjects who were better students (as measured by grade point average) were more likely than were low G.P.A. students to use mnemonic techniques spontaneously on a free recall task. Subjects in this experiment were given no instructions on how to memorize a list of 20 words, yet superior students spontaneously used a variety of mnemonic techniques. This difference may be due to training in the use of mnemonic strategies or previous experience in memorization which led to the development of individual mnemonic techniques. Therefore, the difference found between these studies may be due to the larger amount of experience the college students had with memorization tasks. A more likely explanation may be that a certain amount of cognitive

development may be necessary for spontaneous use of mnemonic strategies. This explanation is supported by a study completed by Scruggs, Mastropieri, Monson, and Jorgensen (1985). They found that gifted fourth and fifth grade students could spontaneously produce more, as well as more effective learning strategies than their non-gifted peers.

Training in the use of mnemonics may encourage younger students to spontaneously use such strategies. It has been shown that although children younger than age seven do not spontaneously use mnemonic techniques, they can be trained to do so (Kramer, & Engle, 1981; Brown, 1975). Rohwer (1970) has demonstrated that mnemonic training with children (age kindergarten through sixth grade) has been quite successful and has enhanced children's ability on paired associate learning tasks. Rose and his colleagues (Rose, Cundick, & Higbee, 1983) have further demonstrated that mnemonic aids, especially visual imagery, have improved recall as well as reading comprehension of elementary-school aged, learning-disabled children.

Several studies have shown age-related changes in a child's ability to use mnemonic techniques, with the consensus being that children show greater sophistication in their use of mnemonic strategies and a corresponding improvement in recall performance with increases in age (Kail, 1979; McFarland, Duncan, & Bruno, 1983; Scruggs, & Laufenberg, 1986; Fabricius, & Wellman, 1983; Guttentag,

1984; Rose, Cundick, & Higbee, 1983). The preschool years appear to be a period of mnemonic dependence. During this time children appear to benefit from mnemonic activity but require continuous external support from parents or other adults to engage in it (Price, Hess, & Dickson, 1981; Price, 1984).

Examples of low-level memory strategies that preschoolers have been shown to use include pointing to target items or giving the items close visual inspection (Baker-Ward, Ornstein, & Holden, 1984). Although very young children may be capable of utilizing low-level mnemonic techniques, they do not appear to be as capable as older children in using more complex strategies. Pressley and MacFadyen (1983) found that preschool age children did not fully use category information they had encoded, unless they were explicitly cued to do so.

Best and Ornstein (1986) investigated the suggestion that exposure to formal educational settings may encourage grade school children to use mnemonic techniques and found evidence to support this hypothesis. The school setting may encourage children to utilize mnemonic strategies by the manner in which the classroom is structured. It has been shown that children's knowledge about their memory systems begins to develop and continues to expand throughout the elementary school years (Kreutzer, Leonard, & Flavell, 1975; Cavanaugh, & Borkowski, 1980). In addition, children's early knowledge

of retrieval cue information becomes extensively qualified and organized during the school years (Fabricius, & Wellman, 1983). Kail (1979) suggests that some of these age-related changes may be due to the growing child's more frequent use of mnemonic strategies to aid retention. Other researchers have stated that a certain amount of cognitive maturity may be necessary in order for children to fully benefit from certain aspects of mnemonic techniques (McFarland et al., 1983).

Although it has been demonstrated that children show greater sophistication in their use of mnemonic techniques with increasing age (Best, & Ornstein, 1986), that the ability to profit from mnemonic strategies interacts with age and ability level (Scruggs, & Laufenberg, 1986), and that older students (7th grade as compared to 4th grade students) can acquire the use of mnemonics faster and use them more often and in different contexts (Bjorklund, 1988), the purpose of the present study is to continue to identify age-related differences and the acquisition of abilities of elementary-age children in regard to mnemonic strategies. It is hoped that this study will highlight the developmental nature of mnemonic technique acquisition.

This study is different from past research in the area of mnemonics in that two distinct mnemonic techniques, one linguistically based and one visually based, were compared. The present study also compared the effectiveness of each

mnemonic with and without regard to order of the to-be-remembered material. In most past research on mnemonics, subjects have been tested without regard to order (Roediger, 1980). In addition, only half as many studies have been conducted comparing the effectiveness of mnemonics for serial recall (the task in the present study) than for free recall or paired associate learning. Many of the studies conducted regarding serial learning have used undergraduate students as subjects; very few have used children (Herrmann, 1987). The present study not only adds to the body of knowledge regarding mnemonics for serial learning in general, but also on children's ability to use mnemonics in serial recall.

Chapter 2

Review of Literature

Elaboration

Elaboration is the key to many mnemonic devices. Elaboration is defined as adding something to what is being learned to make it more memorable (Scruggs, & Laufenberg, 1986). It is a process by which the individual "builds up" the to-be-remembered material by adding detail and complexity to the information. This can be accomplished by putting words which are to be recalled into a sentence or visual image. For example, if an individual wishes to recall the word pair BEAR-BICYCLE, he or she may elaborate the word pair by placing it into a sentence (The bear is playing with a bicycle), or imagining a visualization of the word pair (picturing a bear riding a bicycle). An elaboration, whether verbal or pictorial, puts the information to be remembered in a more meaningful context, which should enhance retention (Carrier, Karbo, Kindem, Legisa, & Newstrom, 1983). Elaboration is an important part of mnemonic techniques because it has been shown that elaboration strategies can dramatically improve learning and memory performance in both children and adults (Scruggs, & Laufenberg, 1986).

Mediational strategies for associative learning are effective if they lead the subject to encode semantic relations between the items to be paired. Thus, an instruction to generate a sentence or an imaginal context for

a noun pair facilitates associative recall if it prompts the subject to discover semantic relations within the pair (Rohwer, & Barr, 1973).

Imagery

The role of imagery in memory has been recognized for many years, and imagery consequently is the center of many mnemonic techniques. Levin (1981) stated that pictures may be an especially useful vehicle for conveying information that an individual wishes to code mnemonically. This hypothesis has been supported by several studies (e.g. Hatano, Amaiwa, & Shimizu, 1987; Higbee, 1979; Kemler, & Jusczyk, 1975; Leighboy, Aslum, Tsoa, & Evans, 1984; Rose, Cundick, & Higbee, 1983) which have found that training in the use of visual imagery has significantly increased elementary school through college age subjects' ability to recall information. Although it appears that mnemonic strategies which employ the use of imagery may be of more benefit than those which do not, the present study compares two mnemonic techniques, one which is imagery centered and one which is linguistically centered, in an attempt to show which techniques are the most efficient.

It has been suggested that there may be some developmental constraints on the utilization of visual imagery as a mnemonic strategy. In a review of the literature, Scruggs and Laufenberg (1986) stated that a certain amount of cognitive maturity may be necessary for a child to benefit

significantly from visual imagery instructions. They found that younger and less cognitively advanced children required additional pictorial support (e.g. being shown a relevant picture), while older or more cognitively advanced students tended to profit from imagery instructions (e.g. to imagine a relevant picture).

Paine (1980) has suggested that visual imagery, specifically eidetic imagery, plays an even more important role in the memory processes of preschool children. Her findings indicate that eidetic imagery is a developmentally important storage mechanism for visual information which facilitates recall of stimulus details by preschool children. Thus, eidetic imagery may function as a primitive mnemonic system.

Visual imagery by itself may not be sufficient to increase recall. Evidence indicates that to make visualizations more effective for use in recalling paired-associate lists, the images must be associated as well as visual (Higbee, 1979; Kemler & Jusczyk, 1975; Roediger, 1980). Morris and Stevens (1974) conducted a review of the literature and concluded that free recall of items is facilitated by mental imagery only when the images that are formed link items together. Imaging the items one after another did not improve recall.

McFarland et al. (1983) investigated the issue of self-generated versus experimenter-supplied mnemonic aids.

They found that children in 2nd through 7th grades who generated their own sentences using to-be-remembered word pairs out-performed children who were supplied with sentences. Kemler and Jusczyk (1975) suggest the semantic relations may be better processed in a self-generation condition than in an experimenter-supplied condition. Rohwer (1970) found similarly that having a child generate his or her own mnemonic aid may be effective because it forces "the child to use his head rather than the experimenter's head" (pp. 417). However, it is possible that the ability to generate effective mnemonic aids, and fully benefit from this activity, requires a certain level of cognitive maturity (McFarland et al., 1983). This may be of relevance to the present study due to the fact that subjects are required to generate their own mnemonic cues. If a certain amount of cognitive maturity is necessary to develop effective visuals, the older subjects should out perform the younger subjects.

Verbal Rehearsal

Verbal rehearsal of to-be-remembered information has proven to be an ineffective mnemonic technique (Herrmann, 1987). However, Rose et al. (1983) have shown that verbal rehearsal is superior to visual imagery in aiding reading comprehension and retention in elementary-school aged children. This finding corresponds with Levin's (1976) assumption that the "ability to generate effective verbal organizations appears, developmentally, to be an earlier

process than the ability to generate effective imaginal organizations" (p. 139). Another explanation for the apparent superiority of verbal rehearsal for young children is that the children may benefit from being able to "hear themselves think". Therefore, acoustic information was added to the semantic information used by these subjects. Also, imagining may require considerable cognitive effort not yet easily produced and maintained by younger children. Therefore, results of the present study may indicate that younger subjects perform better in the linguistic condition than the visual condition due to the fact that it appears they can utilize semantic information more effectively than visual information.

Verbal associations appear to be an effective method of retaining information to be recalled (Borges, Arnold, & McClure, 1976; Herrmann, 1987). In real-life situations, retaining the information may not be sufficient, as often the order of recall is of crucial importance, such as following a set of instructions in building an object, combining ingredients in a cooking recipe, or solving a mathematical problem. Roediger (1980) stated that results of studies which have not found retention improvements when using mnemonics may in part be due to the type of recall test used. Often, subjects are asked to recall materials in any order. Roediger suggests that mnemonic techniques may be the most useful when a person needs to recall items in a specific

order. "It may be that the most common mnemonic devices, though aiding somewhat the number of items recalled, have their greatest effect in the recall of the order in which the items occurred" (p.560). This is due to the fact that several mnemonic techniques require the subject to connect the words to be remembered in a certain order. Roediger found that when college-age subjects were compared on free recall versus ordered recall, those using mnemonics out-performed a control group. However, the differences were larger when the goal task was to recall the material in the order presented.

A technique recommended by Young and Gibson (1962) for learning serial lists is the "chaining" or story-generation method where individuals are instructed to construct a narrative story around the critical words to be remembered. This technique is of added benefit due to the fact that the information can be recalled in the order of presentation as the person recalls the story. This method allows a wide latitude in constructive details (e.g., the number of critical words per sentence) depending upon the ease of organizing the particular lists of words to be learned. The story generation method appears to be especially effective when subjects are tested for delayed recall (Borges et al., 1976).

The success of story generation as a mnemonic technique has been demonstrated by several researchers (Herrmann,

1987). It has proven more effective than rote learning (Bower, & Clark, 1969) and peg word mnemonics (Santa, Ruskin, & Yio, 1973). Bower and Clark found that college students using story generation were able to reacall 6-7 times more than their control group.

The success of narrative story generation as a memory aid has been attributed to thematic organization (Bower, & Clark, 1969). It was suggested that subjects generate meaningful sentences to relate to successive words, and try to organize these words around a central theme. The central themes of different lists are kept distinct from one another, and the first word of the lists cues recall for the story. Herrmann, Geisler, and Atkinson (1973) suggested that the beginning and end portions of the story serve as anchors to its recall and are thus remembered better. Borges et al. (1976) suggest that reconstruction of the word list appears to be heirarchial (recall of the next word is built upon recall of the previous word) when using story generation. Herrmann et al. (1973) found that recall was higher for subjects who created and told the story than for subjects who passively listened to the story. This effect may be due to the cues being more memorable if the subject is forced to build a story around them. Kemler and Jusczyk (1975) suggest that semantic relations may be better processed in the self generation condition. Several studies have shown that mnemonics are most effective when they combine both visual

and verbal elaboration (Scruggs & Laufenberg, 1986; Kemler & Jusczyk, 1975; Rose et al., 1983).

Several investigators have successfully trained children to use mnemonic strategies. In a study by Pressley, Levin, and Miller (1981), fifth grade children were taught the English translations of Spanish words by using associative imagery. Levin (1981) also has shown that mnemonics are useful for learning English vocabulary words, medical terminology, lists of states and their capitals, as well as names of presidents. Carrier et al. (1983) suggest that systematic use of mnemonic techniques could reduce time spent on simple acquisition of various kinds of information and enable students to spend more time on higher level cognitive activity. Higbee (1976) also suggests that mnemonic strategies could be used in practical learning tasks such as in school. Successful training in mnemonics has been shown in such varied populations as learning disabled students (Veit, Scruggs, & Mastropieri, 1986) and gifted learners (Scruggs, Mastropieri, Jorgensen, & Monson, 1986). Thus, training in mnemonics for children seems to have some merit. Rose et al. (1983) commented that learning disabled children can be taught memory strategies quickly and efficiently, and that with practice these strategies could be adapted to many learning tasks.

Roediger (1980) addressed the issue of what type of control group should be used in a mnemonic strategy

experiment. He suggests that subjects should be given elaborative rehearsal instructions; subjects should be told to repeat the words to themselves and to think of the word's meaning while doing so. He stated that this is more appropriate than an uninstructed control group because subjects' motivation may be affected by the belief that they are being taught an effective method of memorization. An elaborative rehearsal control group is more appropriate than a simple rehearsal condition in which subjects are instructed to repeat the words, since such a condition might actually produce worse recall than no instructions (Glanzer, & Meinzer, 1967).

The present study investigated age-related changes in the effects of training in the use of mnemonic strategies. The method of loci is compared with the story-generation mnemonic. The particular mnemonics were chosen because of their effectiveness for serial learning (Herrmann, 1987), the task examined in the present study. In his review of the literature, Herrmann only reported three studies indicating which type of mnemonic techniques are most appropriate for serial learning. It appears that a wider range of research techniques are needed to answer this question fully. In addition, the three studies cited by Herrmann all used college undergraduates as subjects. Therefore, the present study supplies needed research on the use of mnemonic strategies for serial learning as used by children.

In the method of loci, one takes a well-learned series of locations such as a path one travels daily or the floor plan of one's home, and in learning a series of items, imagines each item at some salient location along the path. When the series is to be recalled, the individual should again imaginarily travel the path, "looking" and calling out the name of the items deposited there.

The story-generation mnemonic consists of an individual creating a narrative story using the key words to be remembered as salient features of the story. The critical words are woven into the story in the order they are to be recalled, and the words should be emphasized in some manner, e.g., by vocal stress, pausing, or by making them main actors or objects in the story. When the list is to be recalled, the person recreates the story, listing the key words in the narrative, thus, recalling the list to be remembered.

These two techniques (method of loci and story-generation) were compared with an elaborative control group in an attempt to determine differences between age groups as well as effectiveness of the two mnemonic techniques. The control group was given elaborative rehearsal instructions, i.e. they were told to repeat the words to themselves while thinking of the words' meanings (Roediger, 1980). Two types of scoring were used: a strict criterion giving subjects credit for a word only if it was recalled in the appropriate position in the list of items to

be remembered; and a lenient criterion which allowed subjects credit for a word recalled without regard to the order of the list. In other words, to receive credit on the strict criterion, all words must have been recalled in the order presented. On the lenient criterion, if a word which was on the list was recalled, regardless of the order, the subject was given credit.

Hypotheses

1) Both mnemonic conditions were expected to score higher than the elaborative control group (Levin, 1981; Pressley, Levin, & Miller, 1981; Carrier et al., 1983; Veit, Scruggs, & Mastropieri, 1986).

2) It was also hypothesized that the older subjects would perform better overall than younger subjects (6th grade > 4th grade > 1st grade) (Kail, 1979; Flavell, 1977). With increases in age children show greater sophistication in their use of mnemonic techniques and a corresponding improvement in recall performance (Best & Ornstein, 1986). Use of mnemonic strategies requires more mental effort from second and third graders than from sixth graders (Guttentag, 1984).

3) Younger subjects were expected to perform better in the story generation condition than in the method of loci condition. Past research has shown that younger children may benefit from verbal mnemonics more than visual mnemonics (Rose et al., 1983; Levin, 1976). Levin (1976) has stated

that developmentally, children are able to create effective verbal organizations prior to effective visual organizations. Scruggs and Laufenberg (1986) suggest that a certain amount of cognitive maturity may be necessary for a child to benefit significantly from visual imagery instuctions.

4) The scoring criterion was expected to influence results by showing a larger difference in support of the use of mnemonics when the strict criterion was used (Roediger, 1980). In other words, when using the strict criterion to score recall tests, it was expected that subjects using mnemonic techniques would score higher than subjects in the control group, and that this difference would be enhanced due to the "mnemonic" subjects being better able to recall the lists in order. This is explained by the strict criterion only giving the subjects credit for a recalled item when the item was listed in the same order as it was presented. The use of mnemonics not only aids recall, but is most beneficial when recall is required to be in the same order as presented.

Chapter 3

Method

Subjects

Subjects consisted of 105 elementary students: 36 in first grade (mean age = 6.5 years), 33 in fourth grade (mean age = 9. 7 years) and 36 in sixth grade (mean age 12 years). Measures were taken to avoid discrepant age differences within one grade level. These age groups were chosen in order to investigate subjects whose age and exposure to formal education span the elementary years. These subject groupings also fit Piaget's (1968) theory of development in that children in the preoperational, concrete operations, and formal operations periods should be represented. According to Piaget, the preoperational period is present until age 6 or 7 (1st grade). Concrete operations is present from approximately age 7 until age 11 or 12 (4th graders are approximately age 9-10 and therefore in the middle of this stage). Formal operations begins at age 11 or 12 (6th grade).

Research on mnemonics has shown a reasonably consistent developmental progression regarding the use of mnemonic strategies (Flavell, 1977; Kail, 1979): (1) infrequent use of strategies among 5- and 6-year-olds; (2) a transitional stage from seven to ten years of age, when strategies may appear depending upon factors related to the strategy itself

and to the context in which the strategy is to be used; and (3) the first inkling of mature strategy use at approximately 10 years of age. The age groups examined in the present study roughly fit this developmental progression.

Children were selected by the elementary-school principal to represent varied racial and SES backgrounds. All participants were from an average classroom setting. Neither special education nor gifted and talented children were included in this study. There were 52 males and 53 females who participated in this study. Males and females were divided equally between treatment conditions.

Materials

A pool of 60 high-imagery words were chosen. High-imagery words were selected from the Paivio, Yuille and Madigan (1968) list of nouns. All words were concrete nouns with an imagery value of 6.0 or higher on a 7 point scale. Concrete nouns have been shown to be higher in imagery value than abstract nouns (Rohwer, 1970). The mean imagery rating of the words chosen was 6.83. The words were approved by an elementary school teacher as to their appropriateness for the youngest age level addressed in this study. It was assumed that if the words could be easily understood by the youngest group, the two older groups would have no difficulty with the words chosen.

A table of random numbers was used to randomly assign words to three lists, each containing 20 words. Roediger

(1980) suggests using a list of twenty words due to the fact that when using shorter lists "the control group performs so well there is little room for improvement" (pp. 560). The word lists were counterbalanced to ensure that all words were used in each of the three techniques. Each set of twenty words was used with each mnemonic technique within each age group. Within each age group one-third of the subjects received the first list, one-third the second list, and one-third the third list. All subjects received a different word list on each trial; therefore, each subject received each word list. The order in which the subject received the word lists was randomly assigned. Positions of the words within the list were also randomly assigned. The three word lists are reported in Appendix A.

Procedure

Children within each age group were randomly assigned to one of three conditions: 1) method of loci, 2) story-generation and 3) elaborative control group. The experimenter controlled for equivalent gender distribution among the three groups.

The children were first given a baseline trial. They were told that the experimenter wanted to see "how well they could remember words", and if they could remember the words in the order presented. Then they were told that a series of 20 words would appear on the screen in front of them and they were to try to recall them as well as possible in the order

the words were presented. Words were presented to the subjects via a slide projector. As each word appeared on the screen the experimenter read the word aloud one time. Immediately following the presentation of a list of words, the subjects were asked to recall them by telling them to the experimenter who recorded them on a sheet of paper with the numbers 1-20 in a column, in the order specified by the subject. The experimenter asked "What was the first word?", and recorded the subject's response. The experimenter then asked "What was the next word?", until the subject had recalled all the words he or she could remember. However, a subject could choose to begin anywhere on the list. Therefore, if a child was able to recall the second word as being DOG and the fourth as being SHOE he or she could tell the experimenter to write them in the appropriate spaces on the list, whether or not he or she could recall the first or third word. Subjects were also instructed that if they recalled a word, but were unsure of its position, they could tell the experimenter to write it at the bottom of the page. All subjects were given five minutes to recall the words. The tests were scored by noting the number of correct responses the subject was able to recall. The experimenter scored each test utilizing the strict criterion and lenient criterion discussed above, and noted them each accordingly. Scores on this test were used as a baseline to compare against scores on recall test III.

All word lists were presented at a 5-second rate via a Kodak Carousel slide projector. A presentation rate of 5-seconds was chosen on the basis that the optimal rate for paired-associate learning is probably between 2 to 4 seconds per pair (Calfee & Anderson, 1971). More complicated mnemonic techniques require presentation rates at least as slow as 4 seconds per item (Higbee,1979), especially those techniques which require generation of imagery (Bugelski, 1970). Bellezza (1981) suggests that failure to use sufficiently slow presentation rates (5 or more seconds) may account for the lack of success of certain mnemonic strategies in some experiments. Each word list was presented to each group one time.

Subjects were then told that they were going to be taught an effective method to help them remember lists of words. Each subject was then instructed how to use the method in the experimental group to which he or she belonged. Instructions given to each condition can be found in Appendix B. Subjects in the control group were told that they were to repeat the words aloud while thinking of each word's meaning. Each subject received an equal amount of training time (10 minutes). A second recall test was then administered for the second series of words. Instructions for recalling the words were the same as used in recall test I. Subjects were then given feedback and explanations regarding the value of the mnemonic methods taught to them. Any questions the children

had regarding the use or utility of the mnemonic strategy were answered at this time. The purpose of this trial was to allow the children practice using the mnemonic technique and to provide them with feedback. Those studies which enhance a child's knowledge of memory by providing informed feedback about the task goal and utility of the mnemonic technique for accomplishing the goal appear to be the most successful (Paris, Newman, & McVey, 1982). A third and final series of words was then presented with the same instructions as stated above. Scores on the third recall test were compared against the baseline scores obtained on the first test to determine overall improvement within each condition.

Chapter 4

Results

Subjects' performance on the recall tests was scored by both a strict criterion (subjects were given credit for a word only if it was recalled in the appropriate position) and a lenient criterion (subjects were given credit for recalling a word if it appeared anywhere on the page). This method of scoring was used to allow separation of the effects of mnemonics in recall of items both with and without regard to their appropriate order. Due to the fact that a subject could conceivably remember all words except one in the correct order, and yet still score very low on the strict criterion, a modified strict criterion score was used. For example, if a subject recalled word one correctly, forgot word two, placed word three in the second blank, and recalled words three through twenty in the correct order but wrote them in the wrong blanks, the subject would only receive a score of one according to the strict criterion. Therefore, the number of items recalled that followed the item presented directly prior to the item listed was tallied. This score was used as the strict criterion.

Results were analyzed by performing two 2 X 3 X 3 X 3 (sex X age X condition X test) factorial analyses of variance. The first analysis used the lenient criterion score as the dependent variable while the second analysis used the strict criterion score as the dependent variable.

In each analysis, there were three between-subjects factors (age, sex, and condition) and one within-subjects factor (test). The two analyses yielded nearly identical results (there were no effects which were significant by the lenient criterion that were not significant also by the strict criterion; however, some were significant by the strict criterion only). Therefore, only the strict criterion results are reported.

The mean numbers of words recalled for each condition in each grade are reported in Table I.

Table I

GRADE	CONDITION	N	TEST		
			1	2	3
Sixth	Control	12	4.00	4.50	4.25
	Loci	12	5.00	9.75	13.42
	Story	12	4.50	8.83	10.58
Fourth	Control	11	3.00	3.55	4.09
	Loci	11	3.27	9.00	11.73
	Story	11	3.09	8.82	10.55
First	Control	12	1.08	2.08	2.00
	Loci	12	1.08	2.58	5.17
	Story	12	1.07	5.08	6.25

The analysis involving the strict criterion showed a significant difference for condition, $F(2,87)=77.87$, $p<.001$; grade $F(2,87)=98.35$, $p<.001$; and test $F(2,174)=318.84$, $p<.001$. Three two-way interactions were identified; condition X grade, $F(4,87)=7.25$, $p<.001$; condition X test,

$F(4,174)=58.5, p<.001$; and grade X test, $F(4,174)=6.82, p<.001$. There was also a three way interaction involving condition X grade X test $F(8,1749=4.06$, $p<.001$. No significant main or interaction effects involving sex were found. Results of the overall analysis are reported in Appendix C.

To further understand the three way interaction, a condition X test analysis of variance was conducted for each grade level. Results of this analysis are reported in Appendix D.

The condition X test analysis for the first graders showed a significant effect for condition $F(2,33)=11.46$, $p<.001$; test $F(2,66)=69.98$, $p<.001$; and condition X test $F(4,66)=12.2$, $p<.001$. Analysis for the fourth graders showed significant effects for condition $F(2,30)=48.02$, $p<.001$; test $F(2,60)=196.9$, $p<.001$; and condition by test $F(4,60)=29.04$, $p<.001$. Sixth graders also showed significant effects for condition $F(2,33)=32.32$, $p<.001$; test $F(2,66)=94.16$, $p<.001$; and condition X test $F(4,66)=22.71$, $p<.001$.

A separate analysis of variance was also completed for the condition at each test for each grade. These results are reported in Appendix E.

Follow-up contrast tests using Tukey B were calculated to determine which conditions differed for each grade level at Test II and Test III. There were no significant differences found between conditions on Test I within any grade level. On recall Test II, first graders did not show a significant

difference between the control condition and the method of loci. First grade subjects using the story mnemonic were able to outperform subjects in the control group ($q= 2.06$, $p<.05$) and the method of loci ($q= 1.88$, $p<.05$). On Test III both the story mnemonic and the method of loci outperformed the control group. No significant differences between the story and loci mnemonics were found, although the number of words recalled in the story condition was slightly higher than the number of words recalled in the method of loci condition.

Fourth grade students using the story mnemonic scored significantly higher ($q= 1.42$, $p<.05$) than the control group. Subjects in the method of loci also differed significantly ($q= 1.3$, $p<.05$) from those in the control group. No significant differences were found between the two mnemonic conditions at the fourth grade level. This was consistent on both Test II and Test III.

On the second recall test, sixth grade subjects recalled significantly more words than the control group when using the method of loci ($q= 2.48$, $p< .05$) or the story mnemonic ($q= 2.27$, $p<.05$). Sixth graders did not show a significant difference between the two mnemonic conditions on Test II. Test III continued to show significant differences for both mnemonic techniques over the control group. However, subjects using the method of loci outperformed those using the story mnemonic ($q= 7.39$, $p<.05$) on the third test.

Both fourth and sixth graders differed significantly from

first grade subjects ($p<.01$). Sixth graders outperformed fourth graders but not by a significant difference.

A grade X condition at Test III analysis was completed. The results of this analysis showed a significant difference for grade, $F(2,96)=79.99$, $p<.001$; condition, $F(2,96)=142.64$, $p<.001$; and grade X condition, $F(4,96)=9.28$, $p<.001$. These results are reported in Appendix F.

Post-testing interviews with each subject revealed that only one subject needed to be disqualified from the study due to prior experience with mnemonic strategies. One fourth grade control group subject reported that she had used the story mnemonic to retain the lists of words shown to her. These data were not used in the analyses reported.

Chapter 5

Discussion

It was expected the results would support the hypothesis that older children would be able to use the mnemonic strategies more efficiently than the younger students due to the fact that they have had more practice in memorization and may be able to see the utility of the mnemonic strategy more clearly. Overall, the sixth graders performed better than the fourth graders who outperformed the first graders (6 > 4 > 1). However, the difference between the sixth graders and fourth graders was much smaller than the difference between the fourth and first graders. First graders were able to score higher using the story mnemonic, whereas the sixth graders performed best using the method of loci. Fourth grade students were able to perform equally well when using either mnemonic technique.

It appears that a developmental trend may be present which enables younger children to use linguistically based mnemonics more effectively, while older children utilize imagery based mnemonics more effectively. This is consistent with past research which has shown that younger children benefit from verbal mnemonics more than visual mnemonics (Levin, 1976; Rose, Cundick, & Higbee, 1983). Scruggs and Laufenberg (1986) relate that a certain amount of cognitive maturity may be necessary for children to significantly benefit from visual imagery instructions.

It appears that a transitional stage may be present at the fourth grade level which allows children at this age to use either technique as effectively as the other. It also appears that the initial development of mature use of mnemonic techniques appears around the fourth grade. This is evidenced by the fact that no significant differences were found between the fourth and sixth grade students. It is likely that as children continue to age and gain more experience with mnemonic techniques, their ability to use them effectively will continue to increase. This may be due to cognitive maturity, exposure to formal education and practice effects. Future research is needed to determine how use of mnemonic strategies continues to develop and become refined.

All grade levels and conditions were given equal training time in the mnemonic condition to which they were assigned. This may have influenced the results obtained due to younger students requiring more training time to effectively use the mnemonic strategies. This may be particularly true for the first grade subjects. On Test II, first grade subjects showed no difference between the control group and the method of loci. However, on Test III, both mnemonic conditions differed significantly from the control group, but not from each other. This may indicate that it takes a longer amount of time for first grade subjects to become proficient at more complicated, imaginal mnemonic techniques. Future research

is needed to investigate the issue of training times for both different age levels as well as for different mnemonic strategies. Scruggs and Laufenberg (1986) have shown that older children are able to acquire mnemonics faster. This is consistent with the suggestion that training time may influence performance when different age groups are being investigated.

Subjects in the control group improved over the three tests. However, this is probably attributable to practice effects. Although control group subjects did show improvement, the level of improvement for the two mnemonic conditions was greater.

Herrmann (1987) stated that serial learning is facilitated mostly by the method of loci, followed by story generation and the peg system. Roediger (1980) found that the order of effectiveness for several mnemonic techniques is as follows: method of loci, pegword system, link mnemonics, imagery and rehearsal (this study did not examine the story generation mnemonic). Few studies regarding serial learning have been conducted using children (Herrmann, 1987). Future research is needed to examine the issue of developmental differences in the use of mnemonic techniques to determine which techniques are most effective at various age levels.

The scoring methods used in the present study (lenient and strict), were employed to determine if differences found between mnemonic and control conditions would be more

significant when order of recall was a factor. Past research has not addressed this issue sufficiently. Methods of scoring serial recall data to investigate ordered versus unordered recall, need to be further examined. Although the present study did not find significant differences between the two scoring criteria, future research in this area is needed to further clarify effects caused by scoring.

The two scoring criteria were expected to affect the results by indicating a larger difference between conditions when the strict scoring criterion was used. This hypothesis was not supported by the results obtained. In past research using strict versus lenient scoring criterion (Roediger, 1980), scoring effects were largest when a delayed recall test was used. It may be that the scoring criterion would have proven significant if a test for delayed recall was employed in the present study. Future research may clarify this issue.

The study of mnemonic devices may be thought of as isolated curiosities of little general interest to researchers of human memory. However, it may be argued that the principles underlying the use of mnemonics are simply more efficient variations of normal memory functions. Therefore, we may be able to learn more about normal memory functions by the study of mnemonics. Miller (1956) commented upon the dramatic improvement that resulted when his subject recoded binary digits into octal digits. Miller stated, "If

you think of this merely as a mnemonic trick for extending the memory span, you will miss the more important point that is implicit in nearly all mnemonic devices. The point is that recoding is an extremely powerful weapon for increasing the amount of information we can deal with" (pp. 94-95).

One criticism of the use of mnemonics is that most popular methods are restricted to remembering a series of words or lists. However, it may be possible to generate mnemonics for many different purposes by keeping in mind the two general principles of providing effective initial registration of the information and good retrieval cues for its later utilization (Roediger, 1980). The only limits to devising efficient systems for memorization would seem to be the rememberer's creativity in developing methods appropriate for the purpose at hand, and the ease of use of the mnemonic developed.

An important practical outcome of research on imagery and verbal processes may be in the area of education. Many authors have suggested that the use of mnemonic strategies may be helpful in the classroom (Carrier et al., 1983; Higbee, 1979; Levin, 1981; Pressley et al., 1981; Roediger, 1980; Rose et al., 1983). A learner must be able to transform and encode much information in the course of schooling. Mnemonic strategies provide both a meaningful context and can be used as retrieval cues. Perhaps with training in the use of mnemonic techniques, learners will

become less dependent upon instructional material to provide elaboration for items to be remembered.

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Appendix A

Word List I		Word List II		Word List III	
Word	Imagery Value	Word	Imagery Value	Word	Imagery Value
doll	6.94	arm	6.96	ankle	7.00
fire	6.66	baby	6.90	bird	6.96
girl	6.83	arrow	7.00	bowl	6.90
lake	6.90	piano	6.85	tree	7.00
vest	6.73	whale	6.96	storm	6.45
nun	6.76	corn	6.90	nail	6.96
sea	6.79	butter	6.92	pipe	6.90
star	6.73	boy	6.93	flower	6.96
apple	7.00	river	6.83	golf	6.10
coin	6.90	plant	6.87	meat	6.93
car	7.00	ship	6.93	harp	6.94
camp	6.56	table	7.00	cabin	6.96
dress	6.93	doctor	6.62	clock	6.94
frog	6.96	flag	6.74	fork	6.94
pole	6.93	lemon	6.96	fox	7.00
horse	6.94	house	6.93	iron	6.87
snake	7.00	dirt	6.66	jail	6.69
book	6.96	ink	6.77	army	6.55
rock	6.96	jelly	6.73	cane	6.93
sky	6.18	king	6.34	fur	6.69
Mean Imagery Value Scores:					
List I	6.83	List II	6.84	List III	6.83

Appendix B

General Instructions For All Conditions:

Today we're going to practice remembering lists of words. I want to see how well you can remember the words. I'll show you the words on the screen in front of you one at a time. I'll show each word one time and read it aloud to you. Try to remember the words as best you can, and try to remember them in the order they were shown to you. When all of the words have been shown, you can tell them to me and I'll write them down (show answer sheet to subject).

When you tell me the words that you remember, try to show me where the word belongs. If it is the first word, tell me to write it by the number 1; if it was the last word, tell me to write it by the number 20. If you remember a word, but don't remember where it goes, tell me to write it at the bottom of the page.

Instructions for Elaborative Control Group:

One good way to remember lists of words is to repeat them over and over. Each time I show you a word, I want you to say it to yourself aloud three times. Let me show you what I mean...(experimenter repeats a word 3 times aloud).

Lets try this way of remembering words now. I'll read five words, repeat them to yourself 3 times.

1. Can
2. Chair
3. Book
4. Shoe
5. Dog

Can you remember all five words? Tell them to me now. What was the first word?, etc. (Experimenter records the words on the answer sheet.) Now we're going to try a long list. It will be hard to remember all of the words, but try as best as you can. Don't worry about how many you can remember, I just want you to try.

Instructions for Method of Loci

One good way to remember lists of words is to picture them in your mind in a place that you know very well. An example would be at your house or your school. Let's try this way of remembering words now. As I read each word, close your eyes and see the object in this classroom. When it's time to remember the words, close your eyes and picture the objects again. Tell me the names of each thing as you see it. I'll read the words - when I read the first one, picture it there - (point to a location in the room) - then remember the next one there (continue until 5 places have been chosen).

(Experimenter gives examples of how wors could be pictured). Read the words:

1. Can
2. Chair
3. Book
4. Shoe
5. Dog.

Can you remember all five words? Tell them to me now. What was the first word?, etc. (Experimenter records the words on the sample answer sheet.) Good. Now we're going to try a long list. It will be hard to remember all of thc words, but try as best you can. Don't worry about how many you can remember, I just want you to try (pass out the answer sheet).

Instructions for Story Mnemonic:

One good way to remember lists of words is to think of a story that uses all the words on the list. An example would be to make a story and have each word be something important in the story. Let's try this way of remembering words now. As I read each word, close your eyes and think of a story that uses the words. When it is time to remember the words, think of the story and tell me the words you can remember.

(Experimenter gives an example of a story using words to be remembered). Read the words:

1. Can
2. Chair
3. Book
4. Shoe
5. Dog

Can you remember all five words? Tell them to me now. What was the first word?, etc. (Experimenter records the words on the sample answer sheet). Good. Now we are going to try a long list. It will be hard to remember all of the words, but try as best as you can. Don't worry about how many you can remember, I just want you to try.

Appendix C

Source	SS	DF	MS	F	P
Between Blocks/Subjects					
Sex	.323	1	.323	.060	
Condition	840.706	2	420.353	77.869	<.001
Sex X Cond	4.022	2	2.011	.373	
Grade	1061.834	2	530.917	98.351	<.001
Sex X Grade	9.180	2	4.590	.850	
Cond X Grade	156.522	4	39.131	7.249	<.001
Sex X Cond X Grd	35.800	4	8.950	1.658	.166
Error	469.644	87	5.398		
Within Blocks/Subjects					
Test	1163.050	2	581.525	318.839	<.001
Sex X Test	9.504	2	4.752	2.605	.075
Cond X Test	426.562	4	106.641	58.469	<.001
Sex X Cond X Test	10.538	4	2.635	1.444	.220
Grade X Test	49.716	4	12.429	6.815	<.001
Sex X Grade X Test	2.216	4	.554	.304	
Cond X Grd X Test	59.272	8	7.409	4.062	<.001
Sex X Cond X Grade X Test	30.062	8	3.758	2.060	.041
Error	317.356	174	1.824		

Appendix D

Condition X Test - First Grade

Source	SS	DF	MS	F	P
Between Blocks/Subjects					
Condition	105.130	2	52.565	11.456	<.001
Error	151.417	33	4.588		
Within Blocks/Subjects					
Test	212.074	2	106.037	69.984	<.001
Cond X Test	73.926	4	18.481	12.198	<.001
Error	100.000	66	1.515		

Condition X Test - Fourth Grade

Source	SS	DF	MS	F	P
Between Blocks/Subjects					
Condition	391.899	2	195.949	48.017	<.001
Error	122.424	30	4.081		
Within Blocks/Subjects					
Test	559.778	2	279.889	169.890	<.001
Cond Test	191.374	4	47.843	29.040	<.001
Error	98.848	60	1.647		
Total	1364.323	98			

Condition X Test - Sixth Grade

Source	SS	DF	MS	F	P
Between Blocks/Subjects					
Condition	507.241	2	253.620	32.321	<.001
Error	258.944	33	7.847		
Within Blocks/Subjects					
Test	448.130	2	224.065	94.160	<.001
Cond Test	216.148	4	54.037	22.708	<.001
Error	157.056	66	2.380		
Total	1587.519	107			

Appendix E

Source	SS	DF	MS	F	P
First Grade - Condition at Test 1					
Condition	.000	2	.000	.000	
Error	28.750	33	.871		
Total	28.750	35			
First Grade - Condition at Test 2					
Condition	62.00	2	31.000	7.481	.002
Error	136.750	33	4.144		
Total	198.750	35			
First Grade - Condition at Test 3					
Condition	117.056	2	58.528	22.480	<.001
Error	85.917	33	2.604		
Total	202.972	35			

Source	SS	DF	MS	F	P
Fourth Grade - Condition at Test 1					
Condition	.424	2	.212	.108	
Error	59.091	30	1.970		
Total	59.515	32			
Fourth Grade - Condition at Test 2					
Condition	211.152	2	105.576	34.291	<.001
Error	92.364	30	3.079		
Total	303.515	32			
Fourth Grade - Condition at Test 3					
Condition	371.697	2	185.848	79.857	<.001
Error	69.818	30	2.327		
Total	441.515	32			

Source	SS	DF	MS	F	P
Sixth Grade - Condition at Test 1					
Condition	6.000	2	3.000	1.394	.261
Error	71.000	33	2.152		
Total	77.000	35			
Sixth Grade - Condition at Test 2					
Condition	188.722	2	94.361	15.813	<.001
Error	196.917	33	5.967		
Total	385.639	35			
Sixth Grade - Condition at Test 3					
Condition	528.667	2	264.333	58.906	<.001
Error	148.083	33	4.487		
Total	676.750	35			

Appendix F

Grade X Condition at Test III

Source	SS	DF	MS	F	P
Grade	506.272	2	253.136	79.986	<.001
Condition	902.872	2	451.436	142.644	<.001
Grade X Cond	117.420	4	29.355	9.276	<.001
Error	303.818	96	3.165		