

VISUAL IMAGERY INSTRUCTION WITH LEARNING DISABLED AND
AVERAGE ACHIEVING STUDENTS

by

Susan Carmel Ferro

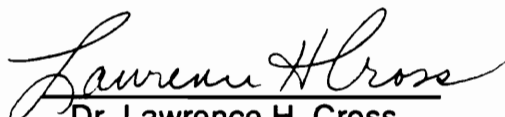
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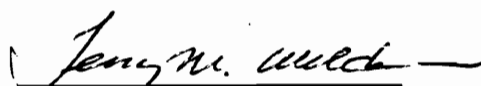
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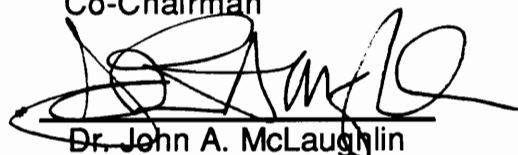
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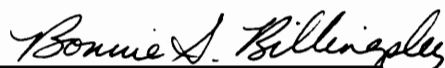
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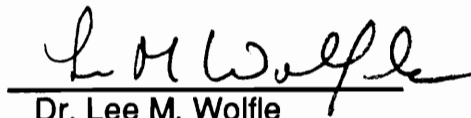
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(ABSTRACT)

The purpose of this two-phase study was to investigate the effects of rate of presentation and type of material on the use of visual imagery in learning disabled (LD) and average achieving (AA) students. In the first phase, a norming study, 15 LD and 15 AA students were instructed to generate images for a list of concrete paired associates. The amount of time required to generate an image and the particular image reported was recorded. Based upon processing time and an image similarity index, 18 easy-to-relate and 18 difficult-to-relate word pairs were identified. Two rates of presentation (5 seconds and 10 seconds) were also determined in the norming study.

In the second phase, an experimental study, 40 LD and 40 AA students were presented with the word pairs derived from the norming study, at a 5 second and a 10 second rate. The experimental task involved learning the word pairs under either imagery or rehearsal instructions. Students were tested for associative recall after each learning trial by being presented one member of each pair and being required to recall its pairmate. Subjects were

subsequently asked to report on the strategies they implemented to learn the word pairs.

Data were analyzed using a 2 x 2 x 2 x 2 (group x instruction x presentation rate x pair difficulty) ANOVA with repeated measures on the last two factors. A series of separate imagery/rehearsal planned comparisons were conducted within each group/presentation rate/pair difficulty combination. In addition, descriptive statistics were computed on the number and types of strategies reported by the students. Both LD and AA students benefited from the imagery strategy with both types of pairs at both rates.

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Chapter 1

INTRODUCTION AND LITERATURE REVIEW

The last one and a half decades have been marked by increasing public concern about the improvement of education. This has created tremendous pressure for educators to provide increasingly effective instruction for all students. Educators who work with learning disabled (LD) students are particularly concerned with effective instructional practices since LD students represent 47 percent of all students with a handicapping condition (U. S. Department of Education, 1989). These students exhibit achievement deficits in spite of average or above average intelligence. Consequently, educators are constantly looking for strategies that LD students can use to be more productive and effective with academic learning tasks.

Researchers have experienced some initial success in teaching learning disabled students to use strategies based on visual imagery (see Clark, Deshler, Schumaker, Alley, & Warner, 1984; Elliott & Gentile, 1986; Mastropieri, Scruggs, & Levin, 1986; Tolfa-Veit, Scruggs & Mastropieri, 1986). No studies, however, have been conducted with LD students to investigate task factors that limit or enhance the use of imagery strategies. A perceived need for such research is reflected by Wong and Wong's (1988) statement that "the constraints of subject and task parameters on cognitive intervention research have never been addressed fully by researchers" (p. 151).

Two task parameters requiring investigation related to LD students' use of imagery are rate of presentation of target material, and type of material. These factors were investigated here with both LD and average achieving (AA) students.

The two-phase study reported here was designed to enhance understanding of the way visual elaboration can be used most effectively to create new and powerful learning interventions for LD students. For learning theorists, the studies were intended to yield data that would further refine knowledge of underlying visual imagery mechanisms. The information produced in these studies should also inform curriculum specialists and teachers about potential factors influencing children's use of imagery strategies.

This first chapter provides a review of the research literature related to imaginal elaborative strategies. The chapter focuses specifically on the theory and research studies that provide a basis for the research questions and methodology employed in this dissertation. Chapter 2 provides a description of the methodology used in the research reported here. Specifically, the chapter provides a description of how LD and AA students were selected, the procedures for the two-phase study, the experimental materials, and the research design. The statistical techniques used, and the results of the study are presented in chapter 3. A discussion of the research findings is presented in chapter 4.

Review of Research on the Use of Imaginal Elaborations

The purpose of this review is to provide an overview and critical evaluation of imagery strategy research with Average Achieving (AA) and Learning Disabled (LD) students. This review is based on the conception of learning as an active process in which learners process to-be-learned materials using their personal funds of prior knowledge and cognitive strategies. Within the context of such a model, research on learning focuses on causative factors within the learner, as well as conditions under which learners with varying characteristics can be successful.

The review is divided into four sections. The first provides a brief historical context for cognitive strategy research. The second section provides an overview of elaborative strategies in associative learning situations. Specifically, the purpose of the second section is to provide a review of studies concerned with imagery strategy usage under instruction. Also, task factors associated with strategy usage will be discussed. The third section includes a description of initial investigations examining LD students' use of visual imagery strategies. Although much progress has been made in recent years regarding visual imagery strategy instruction, the literature still provides only limited guidance in isolating the conditions under which LD and AA children will benefit from such interventions. The fourth section is comprised of the rationale and hypotheses that guided the present two-phase investigation.

Learning and Cognitive Strategy Research

Until the 1960s most of the research in learning was within the framework of behavioral psychology and often gave no particular preference to human over animal learning. During the 1960s, research on learning, especially verbal learning, began to reflect views consistent with a cognitive orientation. According to the cognitive view, the individual plays a crucial role in learning by determining what and how much he learns. The learner essentially mediates the relationship between the stimulus and the response. Topics such as meaningful verbal learning (Ausubel, 1963), discovery learning (Bruner, 1961), imagery (Paivio, 1969, 1971), generative learning (Wittrock, 1974, 1978), and mnemonics (e.g., Bower, 1970) have since appeared as dominant features in the research on learning.

In the late 1960s, psychologists became intensely interested in human information processing (Neisser, 1967). Models of information processing developed at that time (e.g., Atkinson & Shiffrin, 1968) gave considerable attention to structural features of the memory system and their associated control processes. The familiar Atkinson and Shiffrin (1968) model, which featured three basic memory stores, was useful in illustrating the various control processes related to selection, maintenance, and loss of information at different stages. Later, the structural models were questioned by Craik and Lockhart (1972) who maintained that the extent to which an individual remembers material depends upon the depth of active

processing or thinking that goes into efforts to learn. Craik and Lockhart (1972) did not rely in their analysis on structural distinctions between various stores such as short- and long-term memory; rather they proposed a "levels of processing" continuum with memory processing ranging from activities suitable to maintaining information in its original state (shallow processing) to more complex procedures that involve meaning (semantic processing). Later versions of the levels-of-processing continuum (Craik & Tulving, 1975) relied more on the concept of elaboration than depth. However, the basic idea of a processing continuum remained, wherein items could be coded into memory as a function of the quality and elaboration of the encoding tasks. By providing an emphasis on subject-controlled processes (encoding and retrieval strategies) and on how information is transformed during learning and remembering, models of memory have directly influenced learning researchers' interest in cognitive strategies.

A popular definition of a cognitive strategy is that it is "composed of cognitive operations over and above the processes that are a natural consequence of carrying out the task, ranging from one such operation to a sequence of interdependent operations. Strategies achieve cognitive purposes (e.g., comprehending, memorizing) and are potentially consciously controllable activities" (Pressley, Forrest-Pressley, Elliott-Faust, & Miller, 1985, p. 4). The search for effective cognitive strategies has involved intensive task analyses and study of how good strategy users perform various

tasks. Cognitive strategy research can be divided into three categories: analytic, comparative, and instructional (Paris, 1988). *Analytic research* examines the influence of particular strategies (rehearsal, elaboration, organization) on learning. Based on this type of research, researchers (Levin, 1986, 1988; Swanson, 1989) have contended that different strategies serve different cognitive purposes. For example, Levin and Pressley (1985) argued that mnemonic strategies facilitate the memory side of vocabulary acquisition, while semantic strategies facilitate the comprehension side. *Comparative research* is designed to investigate strategic differences ensuing from age, I. Q, background, and learning style. For example, reading researchers have studied strategic differences between good and poor readers (Paris & Myers, 1981; Ryan, 1981). Poor readers are found to be deficient in the use of various strategies, whereas good readers possess repertoires of effective strategies which they draw on in meeting task demands. Research on *strategy instruction*, which is based on analytic and comparative research, involves instructing inefficient learners in effective strategies and assessing the effects of the instruction. For example, researchers have demonstrated that effective strategy instruction can improve performance of inefficient learners on a variety of academic tasks such as reading, writing, mathematics, and memory (Billingsley & Wildman, 1988; Harris & Graham, 1985; Mastropieri, Scruggs, McLoone, & Levin, 1985).

One important conclusion that follows from cognitive strategy

research is that there are task and person factors that influence the use of cognitive strategies (Pressley, Heisel, McCormick, & Nakamura, 1982). Hence, an important goal of cognitive strategy research is to isolate variables that educators can manipulate to maximize learners' success in the learning process.

Imaginal Elaborative Strategies

Currently, several theorists have suggested an active elaborative conception of learning (Rohwer, 1980; Shuell, 1986; Wittrock, 1974). Under such a view effective learners relate to-be-learned material to information that the learner already possesses. Since elaborative strategies are not acquired naturally by everyone (Pressley, 1982), and since a goal of education is to develop autonomous learners who spontaneously elaborate on the material they are learning, it is necessary to instruct students in these strategies and determine the conditions under which they are most appropriate. This section reviews selected research on elaboration strategies with particular attention given to the role of visual imagery.

Elaboration Strategies

Elaboration strategies can be defined as "the methods effective learners use to relate incoming information to previous knowledge" (Weinstein & Underwood, 1985, p. 248). Weinstein and Mayer (1986) distinguished between two types of elaboration strategies: 1) elaboration strategies for basic learning tasks; and 2) elaboration strategies for complex tasks. The former pertains to using an image

or a sentence to relate paired-associate items. The latter entails the use of paraphrasing or summarizing to relate new information presented in prose to knowledge already possessed by the learner. This research focuses on the use of elaborative strategies for basic tasks. Rohwer (1973), whose work involved paired-associate learning, maintained that elaborative strategies facilitate learning by placing the items to be associated in an "episode, process, or relation involving the items" (p. 5). For example, in learning the word pair ball and dog, the learner will likely generate an interactive image of a dog playing with a ball.

There are several aspects of elaborative strategies that give such procedures an advantage over other strategies such as rehearsal and categorization. For instance, in constructing elaborations, subjects form a definite relationship between the to-be-remembered event and additional information already present in the learner's knowledge base. In contrast, when subjects use rehearsal, which involves repetition of exactly the content that is to be learned, they do not create anything. Similarly, the employment of categorization strategies (Moely, 1977) requires the learner to use only knowledge that is already well known to him/her (e.g., category headings and synonyms).

Subjects' performance on associative learning tasks tend to improve when they are instructed in the use of elaborative strategies. For example, memory improvements on a paired associate task were obtained with children in grades 1, 3, 6, and 11 as a

function of verbal elaboration instruction (Rohwer & Bean, 1973). In their study, Rohwer and Bean (1973) asked subjects in each grade to learn word pairs under four experimental conditions. In the *listen* condition, subjects were just asked to learn the word pairs by attending to them as they were presented. In the *rehearsal* condition, subjects were asked to repeat each word pair during the inter-item interval. In the *presentation* condition, subjects were required to repeat an experimenter-provided sentence, which included the word pairs, during the inter-item interval. For example, following the presentation of each noun pair (hammer-bell), the word pair was presented in a sentence context (e.g., the hammer hit the bell). In the *construction* condition, subjects were asked to construct a sentence containing each noun pair presented. In addition, they were required to repeat the sentence during the inter-item interval. Rohwer and Bean (1973) found that subjects in the sentence conditions outperformed subjects who were not instructed to elaborate upon the word pairs verbally. Also, facilitation in recall has been evidenced when subjects are instructed to use pictorial and imaginal elaborations (Ferro, Weller & Franchina, 1989; Pressley & Levin, 1980; Rohwer, Ammon, Suzuki & Levin, 1971).

Besides facilitating performance for basic paired-associate tasks, elaborative strategies promote learning in school tasks that have prominent associative components. For example, when Levin, Johnson, Pittelman, Hayes, Levin, Shriberg, and Toms-Bronowski (1984) asked high and low achieving elementary school children to

learn native language vocabulary words, they found that learning was better under an elaborative strategy condition than a semantic control condition. Similarly, recall for foreign vocabulary words was improved when sixth graders were instructed in the use of an elaborative strategy (Pressley, Levin, Hall, Miller, & Berry, 1980). Elaborative strategy instruction has also been used to improve students' memory for other curricula content such as states and their capitals (Levin, Shriberg, Miller, McCormick & Levin, 1980), science facts (Scruggs, Mastropieri, Levin, & Gaffney, 1985), and cities and their products (Pressley & Dennis-Rounds, 1980). Learning can be improved with both verbal and imaginal elaborations; particularly relevant here, it can be improved by construction of interactive images.

Elaborations Based Upon Visual Imagery

Efficient associative learning and memory depend upon establishing meaningful connections between stimuli and responses (Anderson & Bower, 1973). Visual imagery facilitates associative learning by building stimulus response linkages through the process of elaboration.

Imaginal elaboration typically involves generation of a common referent (interactive image) for the two items to be remembered. One member of the pair then serves as a retrieval cue for the common referential event. For example, when given the word pair *car-orange*, the individual can form an interactive image of a *car* running over an *orange*. At the time of retrieval, the cue *car* will

retrieve from memory the previously formed image which is then easily decoded into the correct response *orange*. According to the elaboration hypothesis (Rohwer, 1973), retrieval of paired items is affected by the quality of the referential event. High quality images integrally incorporate the two items to be coded together into memory.

The research on imaginal strategies falls into two general categories. The first includes strategies with only an imagery component. The second includes strategies that have a keyword or pegword component and an imagery component. The keyword mnemonic, proposed by Atkinson (1975), attempts to enhance learning by recoding an unfamiliar stimulus item into an acoustically similar familiar word (keyword) and relating it to the to-be-remembered response by means of an interactive image or picture. Later, when the stimulus is presented, the acoustic association should come to mind, which would permit access to the interactive image or picture, which results in the retrieval of the desired response. For example, to remember that the Spanish word *carta* means letter, a keyword like cart could be used, and an interactive image of a letter in a cart could be formed. Similarly, the pegword method entails using a peg-word rhyme, "one-bun, two-shoe, three-tree...", and forming an image of the peg-words interacting with the to-be-learned material.

Researchers have compared subjects' performance under imagery and control conditions. Typically, imagery studies have

included subject-generated and/or experimenter-provided conditions. In the first instance subjects are instructed to generate keywords and/or images. In the second instance subjects are provided with keywords and/or images. Comparisons of subjects' performance under experimenter-provided and subject-generated imagery conditions have yielded mixed results. In some studies (Pressley, Levin, & Miller, 1982; Schwartz & Walsh, 1974), no significant differences were evidenced between experimenter-provided and subject-generated imagery conditions. In other studies, performance under subject-generated imagery conditions have proven superior to performance under experimenter-provided imagery conditions (Treat & Reese, 1976), but sometimes worse (Ott, Butler, Blake & Ball, 1973; Pressley & Levin, 1978). There is no clear empirical evidence regarding which type of imagery condition is more effective. Researchers (e.g., Paivio & Desroches, 1981) have contended, however, that adult subjects appear to benefit under self-generated conditions whereas younger subjects benefit from experimenter-provided visualizations.

Control conditions in imagery studies have included repetition, own-strategy, and/or semantic contextual procedures. Students in imagery conditions consistently have outperformed students in no-strategy control conditions (Pressley, 1987; Hall, 1988), repetition control conditions (Pressley, Levin, Hall, Miller, & Berry, 1980), and semantic-context conditions (McDaniel, Pressley, & Dunay, 1987; Sweeny & Bellezza, 1982).

Factors Influencing the Use of Imagery Following Instruction

Based on the past 15 years of research, researchers have concluded that use of imaginal elaborative strategies follow a complex developmental pattern (Pressley, 1982; Schneider & Pressley, 1989). Development of imagery generation skills continue until the end of the elementary school years, at which time children are able to generate interactive images under fairly rapid presentations, with materials presented verbally only, ones that are not obviously related (Schneider & Pressley, 1989). This section focuses specifically on empirical studies establishing when children can benefit from imagery strategy instruction.

Age effects. In an attempt to assess the age at which children can apply instructions to use imagery strategies, Wolff and Levin (1972) varied instructional conditions for kindergartners and grade-3 children. Using a paired-associate task with concrete common objects (toys), four conditions were employed: control, imagery-prompting, experimenter-provided interaction, and learner enactment. At the third grade level the three experimental conditions yielded better results than the control condition. But at the kindergarten level, although the experimenter-enacted and subject-enacted instructions produced more learning than in the control condition, kindergarten students were unable to benefit from instructions to imagine the toys "playing together". Support for these findings was obtained by Levin, McCabe and Bender (1975) who reported that children prior to 5 years of age cannot benefit from

imagery instructions. In a subsequent study, however, Bender and Levin (1976) maintained that 4 year olds could benefit from imagery instruction only if they were provided with extensive prompts and environmental support (e.g., presenting the pairs as toys instead of as words). Similarly, 6-year-olds could benefit from imagery instructions only when they were provided with high imagery word pairs, and adequate time for image generation (Pressley & Levin, 1978). Between 7 and 11 years of age, image-generation skills continue to develop. By 12 years, situational constraints associated with these skills are comparable to constraints observed with adults (Pressley, 1982).

Researchers (Pressley, Heisel, McCormick & Nakamura, 1982) have concluded quite logically that learning situations can be structured in such a way that learners will find it either physically impossible or relatively easy to execute a learning strategy effectively. For example, Pressley and Levin (1977) demonstrated that although a visual imagery strategy was beneficial for both second and sixth graders in recalling paired-associate nouns, the benefits of the two groups varied depending on the way the learning situation was structured. On the one hand, sixth graders could benefit from imagery instruction for items that were obviously related and even for items that were not so obviously related regardless of the rate of presentation. By contrast, second graders benefited from imagery instruction only when pairs were presented at a slow rate and when obviously related pairs were presented at

the fast rate. Younger children's failure to use the imagery strategy with not so obviously related pairs at fast rates was attributed to lack of accessible elaborative relationships in the knowledge base. Consequently, it took the younger students more time to arrive at meaningful relationships between the pair members.

Rate of presentation. Although rate of presentation of the target material is an important situational factor affecting the use of imaginal elaboration, there appears to be no clear cut empirical evidence regarding optimal rates at which words should be presented to render imagery instructions effective. Researchers, however, have provided differing views regarding the amount of presentation time per item pair required to generate an image. Bugelski (1962) maintained that it takes time for images to become active in paired-associate imagery studies, and that a customary 2-second rate of presentation of verbal materials is inadequate for effective image generation. Bellezza (1981) agreed that failure to find evidence of mnemonic effectiveness in some experiments could be attributed to failure to use sufficiently slow presentation rates. Higbee (1977) indicated that rates of at least 4 seconds per item should be used. Bugelski, Kidd, and Segmen (1968) demonstrated that on a single trial, subjects using imagery outperformed subjects in control conditions at presentation times of 4 and 8 seconds. No differences between the two groups were observed at a 2 second rate. Yet, contrary to these findings, Pressley (1987) demonstrated that imagery can be used effectively at fast rates (3 seconds per

pair). Ferro et al. (1989), provided support for this finding in a related study where imagery effects were obtained at 2-, 4- and 8-second rates.

Varying rates of presentation, that is, 6 to 15 seconds, have been used in imagery studies with children (Beuhring & Kee, 1987; Pressley & Levin, 1978; Pressley & Levin, 1977). Rate of presentation appears to be a salient variable for younger children especially since they are expected to be generally slower in producing mediators compared to older children. In the Pressley and Levin (1977) study, older children benefitted from the imagery strategy with both easy and difficult word pairs regardless of the rate of presentation. Elaboration instruction improved younger children's learning only when the word pairs were presented at a slow rate.

Characteristics of the study material. Another situational variable that affects performance under imagery instructions is the nature of study material to be learned. Abstract pairs obtain lower imagery ratings than concrete pairs (Paivio, Clark & Khan, 1988). Additionally, longer image latencies have been reported for abstract pairs (Yuille, 1973). Researchers (Paivio, 1971; Day & Bellezza, 1983) have long contended that concrete words are better recalled than abstract words. The effects of concreteness are clearly obvious in paired associate tasks where to-be-learned items must be associated. It has been demonstrated consistently that image based techniques do not enhance recall if the to-be-learned materials are low imagery

abstract pairs (Foth, 1973; Groninger, 1974).

Another factor that appears to affect the ease of forming compound images is "associative relatedness" (Day & Bellezza, 1983). That is, integrated images may be more easily or directly generated for related pairs such as dog-bone or liberty-justice, than for unrelated pairs such as dog-rose or liberty-zoology. Researchers have contended that the use of an elaborative strategy is effected by the "relatedness of the to-be-learned" material (Kee & Davies, 1990; Pressley & Levin, 1987; Rohwer et al., 1982). Rohwer et al. (1982) maintained that easy-to-relate word pairs are more accessible in the knowledge base than difficult-to-relate word pairs. Elaboration of easy-to-relate (easily accessible) word pairs requires only that the learner locate information in his/her knowledge base that overlaps with the to-be-learned material. On the other hand, elaboration of difficult-to-relate word pairs requires additional information processing stages including locating information for each item, selecting information that can encompass both items, and transforming the information so that both items can be included.

Looking at imagery and relatedness together, Day and Bellezza (1983) and Paivio et al. (1988) found that low relatedness depressed imagery ratings for unrelated concrete pairs. However, although unrelated concrete pairs obtained lower imagery ratings, they were recalled more often than related abstract pairs (Paivio et al., 1988).

In short, the effectiveness of self-generated imagery instruction with AA learners is due in part to interactions with tasks

and knowledge base factors. Consideration of these factors is also necessary in designing instruction for other student populations such as students with learning disabilities.

Imagery Strategy Instruction and Learning Disabilities

Traditional conceptualizations of the characteristics of individuals with learning disabilities have included deficits in visual perception (e.g., Cruickshank, 1972), "psycholinguistic" ability and visual auditory integration (Kirk & Kirk, 1971), and attention (e.g., Tarver, Hallahan, Kauffman, & Ball, 1976). However, recent conceptualizations have been influenced by the sizable body of research establishing memory deficits in learning disabled learners (see Swanson, 1987). Researchers have offered differing views regarding the nature of memory deficits. Some have argued that individuals with learning disabilities exhibit both structural (how information is stored and organized) and procedural (operations carried on semantically stored information) deficits (e.g., Baker, Ceci, & Hermann, 1987). Others have argued that structural deficits are less likely, and have attributed differences between LDs and AAs to processing deficits (e.g., Dallago & Moely, 1980; Torgesen, 1977). For example, Dallago and Moely (1980) found that reading disabled (RD) children were not impaired in using semantic relationships to cluster information. They concluded, further, that poor recall in RD children could be attributed to difficulty in spontaneously generating effective, organized study behaviors.

Furthermore, researchers have offered differing views

regarding LDs' deficits in semantic processing. Some have attributed deficits in semantic processing to deficits in automatic processing (Sternberg & Wagner, 1982), while other researchers have attributed these deficiencies to failure to engage in purposive processing (Bauer, 1982; Goldstein, Hasher & Stein, 1983). Automatic processing deficits, which are not amenable to practice and education, have been attributed to nervous system insults (Hasher & Zacks, 1979; Tulving, Schacter & Stark, 1982). In contrast, deficits in purposive processing, which are amenable to practice and education, have been attributed to a number of factors including lack of a well developed knowledge base and/or lack of motivation (e.g., failing to use a strategy which the individual already possessed). Based on his evidence that LD students are relatively deficient at purposive rather than automatic semantic processing, Ceci (1984) concluded that "instead of advocating intervention plans that are directed at remediating alleged cerebral insult or dysfunction, a more profitable approach to children with semantic difficulties..... is to train purposive information processing strategies like elaborative encoding, chunking, anticipation, type-2 rehearsal, and so on" (p. 219). One class of purposive information-processing strategies, which has relevance to LD students, are elaborative strategies based on visual imagery (see Elliot & Gentile, 1986; Mastropieri, Scruggs, Levin, Gaffney, & McLoone, 1985). As discussed earlier, elaborative strategies facilitate learning of associative factual information. Since associative factual information constitutes much of what children

learn, and since LD students exhibit deficits in learning verbal associates (Vellutino & Scanlon, 1982), elaborative strategies can serve as potentially valuable instructional adjuncts for these students.

Researchers have repeatedly demonstrated the efficacy of elaborative image-based techniques (e.g., keyword and peg word methods) with LD students (Mastropieri, Scruggs & Levin, 1985; Scruggs, Mastropieri, Levin, & Gaffney, 1985; Tolfa-Viet, Scruggs, & Mastropieri, 1986). Imagery conditions have included both experimenter-provided and self-generated conditions. Control conditions have included traditional drill-and-practice rehearsal methods (e.g., direct instruction) and "own strategy" conditions. Direct instructional conditions have been claimed to be "optimal" instructional procedures for LD students and other inefficient learners (Becker, Engelmann, Carnine, & Maggs, 1982). Direct instruction involves students' active responding, instructor provided reinforcement, and repetition of the to-be-learned material (Scruggs, Mastropieri, Levin & Gaffney, 1984).

To date, most of the imagery studies with LD students have included experimenter-provided imagery conditions. In only a few studies have LD students been instructed to generate their own keywords or images (Elliot & Gentile, 1986; Mastropieri, Scruggs, Levin, Gaffney, & McLoone, 1985; Mastropieri, Scruggs & Levin, 1985). The findings from the research conducted thus far, however, indicate that LD students can benefit from instructions to use self-

generated imagery strategies. Nevertheless, before definitive comments can be made about the effectiveness of these strategies, additional fine-grained investigations are in order.

Self-generated Imaginal Elaborations: Initial Explorations.

The three studies discussed here were conducted to investigate the effects of self-generated imagery instructions on LD students' associative learning. Mastropieri et al. (1985, Experiment 2) instructed LD junior high students to use the keyword method to learn 14 low frequency English vocabulary words. Students were provided with keywords and were asked to generate their own interactive images. LD students in the self-generated strategy condition outscored students in a direct instructional condition. In another vocabulary study, McLoone et al. (1986) reported that LD adolescents could generate their own keywords and images after being mnemonically trained. In fact, students in the self-generated mnemonic condition outperformed students in the directed rehearsal condition. In a study involving learning disabled and average achieving junior high students (Elliott & Gentile, 1986), those instructed in an image based strategy (peg-word method) had significantly higher recall scores compared to control students who were asked to study the pairs using their own techniques.

It is apparent that LD students can benefit from instructions to generate imaginal elaborations. Several important issues, however, are not clear and warrant additional investigation. In each of the studies, slow rates of presentation, ranging from 10 seconds (Elliot &

Gentile, 1986) to 30 seconds (McLoone et al., 1986) were used. These relatively slow rates may have made it possible for the LD students to execute the imagery strategy even if the material was difficult to elaborate. Thus, it could be possible that faster presentation rates might constrain LD students' use of the self-generated strategy, especially with difficult-to-relate word pairs. Therefore, in evaluating the efficacy of the self-generated strategy with LD students, researchers need to carefully consider the effects of person and situational factors.

Rationale for the Study

Imagery researchers (e.g., Pressley & Levin, 1977) have investigated situational constraints (rate of presentation and type of material) that potentially limit the usefulness of imagery strategies with AA students. Since LD students are presumed to be less effective learners in comparison to AA students, it is inappropriate to generalize across task and subject populations when deciding how imagery strategies best facilitate learning. Even if certain visual imagery strategies are effective for AA students, given a particular set of conditions, they may prove less beneficial with LD students. Pressley (1987) suggested conducting aptitude by treatment studies as a way to assess the generality of treatment effects. These kinds of studies should be conducted especially when there are clear hypotheses about how differences in learner processing capabilities relate to learner success. Specifically, research exploring the use of visual imagery strategies with LD students should simultaneously

investigate the effects of important task variables in order to provide more definitive information about when and how such strategies improve learning. Accordingly, the research reported here examined the effects of rate of presentation and type of material on the use of visual imagery by LD and AA students.

The investigation was conducted in two phases. The first phase was a norming study in which 15 LD and 15 AA students were presented a list of paired associates and were instructed to generate images containing the paired items. The norming study was designed to accomplish three purposes: 1) to arrive at two types of word pairs, those that were obviously related and consequently lent themselves easily and quickly to imaginal elaborations (easy words) and those that were not (difficult words); 2) to determine two rates of presentation considered slow and fast for both AA and LD students; 3) to determine whether LD students' use of visual imagery within restricted time periods might be constrained by the amount of time it takes them to read word pairs compared to AA students. Essentially, the norming phase was designed to determine empirically the task parameters (i.e., presentation rate and pair difficulty) under which the main experiment was to be conducted. Since no such norming study had been conducted with LD students (Pressley and Levin did conduct such a study with AA students in 1977), the information gained here was considered essential to proceeding with the second phase.

The second phase was designed to examine experimentally the

effects of rate of presentation (slow and fast) and type of material (easy-to-image and difficult-to-image) on the use of a visual imagery elaboration strategy with LD and AA students. The experimental task involved learning 36 paired-associates (18 easy and 18 difficult) with imagery or rehearsal instructions, followed by a test in which the first word of each word pair was presented as a cue to recall the second word.

This study was based on the premise that the success of imagery instructions would depend on the type of learner, ease of mediator production for specific pairs, and amount of study time provided for each word pair. The main hypothesis was that LD students would only be able to benefit from imagery instruction with easy-to-relate pairs and/or when the word pairs were presented at a relatively slow rate.

Chapter II

METHODOLOGY

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Subjects

Subjects were 110 students selected from six schools in two public school systems serving heterogeneous student populations. These students were selected from the total population of sixth and seventh grade male students within the two school systems. The sample included equal numbers of learning disabled (LD) students (n=55) and average achieving (AA) students (n=55). Parental consent was obtained prior to participation (see Appendix A).

Subjects' ages averaged 12.4 years for LD students (range 11.8 to 13.11 yrs) and 12.3 years for AA students (range 11.3 to 13.8 yrs). Only males were included in this study since learning disabilities are at least twice as common among boys as among girls (Broman, Bien, & Shaughnessy, 1985). Consequently, it would have been very difficult to obtain a sufficient number of females for a balanced design to control for possible gender effects. The sample was largely Caucasian (97%), the remainder were black students.

Selection Criteria for LD Subjects

All learning disabled students were determined to have a learning disability prior to the study. In accordance with federal and state guidelines, students were found eligible for special education services by school district personnel through a formal, multidisciplinary assessment process. Prior to data collection, the cumulative school records of the LD students from both school

systems were reviewed. To qualify for participation in the study LD students were required to have a Full Scale IQ of 90 or above and a Verbal IQ above 80 on the Wechsler Intelligence Scale for Children-Revised (WISC-R, Wechsler, 1974). These restrictions were specified in order to avoid differences that might be attributed to below average general intellectual ability. The Mean Full Scale IQs for the LD subjects was 101 (range = 90 - 124). In addition, it was necessary that LD students' achievement scores be at least one standard deviation below IQ expectations in one or more academic areas. Seventy-eight percent of the LD students had primary disabilities in the area of reading (n=43), 11% in language arts (n=6), and 11% in math (n=6).

Selection Criteria for AA Subjects

The 55 AA boys were selected from classrooms having the same general characteristics as those from which the LD students were selected. AA students were required to score within plus or minus one standard deviation (3 points) of the mean (10) on the vocabulary subtest of the WISC-R to ensure that they were within the average range. AA students' national percentile ranks on the Iowa Test Of Basic Skills (1988), for reading, language, and math, fell between the twenty-fifth and the seventy-fifth percentile indicating that students were performing in the average range in these areas.

Norming Study

Fifteen LD and 15 AA subjects were selected from the above subject pool to participate in the norming study. Each student was instructed to generate images to a list of word pairs presented on a computer. The norming study was to identify 18 easy-to-relate and 18 difficult-to-relate word pairs based upon processing time and an image similarity index. Two rates of presentation (slow and fast) for the main study were also determined in this norming study.

Materials and Procedure

Materials included a total of 150 concrete words (e.g., knife, orange, milk). These words, familiar to sixth and seventh graders, were obtained from a restricted pool of 250 words from the Dale and O'Rourke (1976) word inventory.

To address possible reading difficulties within the LD sample, the norming study was prefaced by a reading recognition task which was administered to the 15 LD subjects. Each student was instructed individually to read aloud the 250 words from the Dale and O'Rourke (1976) list. The purpose of the procedure was two-fold: 1) to ensure that the subjects had the necessary sight vocabulary to read the material; 2) to arrive at a list of 150 words to be used in the actual norming study. A word was included in the final list if all students were able to read and recognize it (i.e., if students could pronounce the word correctly, and/or did not hesitate reading the word). The final 150 words were then paired based on lists used by previous

researchers (e.g., Rohwer & Bean, 1973). Some of these words were paired so that there was an obvious relationship (e.g., bread-butter); others did not have obvious relationships (e.g., bathtub-swing).

The 15 LD and 15 AA students participated in the norming study in a quiet area in the school building. Each student worked individually with the same experimenter. The session included instructions to the student in the use of the imagery technique which included appropriate examples (Appendix B), and a brief training phase wherein each student was provided with three practice pairs. In the training phase each student was individually instructed to follow four steps: read the word pairs aloud as soon as they appeared on the computer, form a mental picture of the two things doing something with each other, press the button on the mouse as soon as the picture was formed, and describe the image to the experimenter (see Appendix C).

After the training phase the 75 word pairs were presented to each student individually and the student was reminded to follow the four steps that were taught to him in the training phase. Each pair was presented for 30 seconds on an Apple Macintosh (512 K) microcomputer. If a student was unable to read and form an image within this period, he was assigned a latency of 30 seconds for that pair. Appearance of each word pair on the screen was accompanied by a high tone produced by the computer. As soon as the student responded by pressing the button on the mouse, or as soon as 30 seconds elapsed from the time the word pairs appeared on the

screen, a low tone (low) was produced signalling the end of the episode. The entire session was audio-taped, and took about 30 seconds to complete.

It was assumed that since LD students exhibit speed of processing and encoding deficits (see Speece, 1987), these students might require more time to process the pairs. Moreover, because LD students may have to allocate most of their resources to overall phonetic processing (Daneman & Carpenter, 1980), they may have little residual processing capacity to carry out the information processing requirements (e.g., storage and retrieval) associated with the imagery strategy. Hence, three measures were obtained to determine whether or not students' use of imagery within restricted time periods was constrained by the amount of time it took them to read the word pairs. Three time measures were -- total time, reading time, and image time. Total time was the time between onset of the word pair on the computer screen and depression of the button on the mouse. This measure was recorded by the computer. Reading time was defined as the time between onset of the word pair on the screen and time taken by the student to read the word pairs aloud. This measure was obtained from the audio tape after the session by using a stop-watch. The stop watch was turned on as soon as the tone was heard (onset of the word pair) and turned off as soon as the subject completed reading both words. Image time was computed by the experimenter by subtracting reading time from total time. After the experimental sessions the experimenter

recorded students' reported images from the audio tape. Like the Pressley & Levin (1977) study, two criteria were used to distinguish between easy and difficult word pairs: consensus and speed (total time). Within each group, a pair was considered easy if it could meet any of the three consensus criteria, namely: 1) if a majority of the students (8 out of 15) reported a similar image; 2) if at least two-thirds (10 out of 15) of the students reported one of the two most common images; 3) if more than three-quarters (12 out of 15) of the students reported any of the three most common images. Further determination of easy and difficult word pairs was based on the amount of time required to read and form an interactive image. The exact use of the latency measures is described in the analysis section below.

Analysis of Norming Data

A mean for total time, reading time, and imaging time was computed for each of the 75 word pairs for LD and AA students. Means and standard deviations for reading and image latencies for LD and AA students are presented in Table 1. The disparity in standard deviations for the reading times between the two groups was in large part attributable to a single LD student whose reading time was 10.00 seconds, much higher than average for his group. When this student's reading time is removed the reading time mean and standard deviation for LD students is ($M= 2.55s$) and ($SD = .42s$). Regardless, no significant reading time difference was found between LD and AA students when this student's reading time was included, t

(14.9) = 1.46, $p > .05$, or was not included, $t(27) = 1.79$, $p > .05$.

Similarly, there was no significant image time difference between the LD students ($M = 2.85s$) and AA students ($M = 2.10s$), $t(28) = 1.33$, $p > .05$.

A total of 52 easy and 23 difficult word pairs, common to both groups, was arrived at based on the three specified consensus criteria. These word pairs were then rank ordered on total time from fast to slow within each difficulty (easy/difficult) and group level (LD/AA). Most critically, for both LD and AA students, the mean total time latency for the first 18 easy-to-relate word pairs

Table 1

Reading And Image Latency Means (M) And Standard Deviations (SD) Associated With 75 Word Pairs For LD And AA Students

Group	Reading Time	Imaging Time
LD	M 3.05	M 2.85
	S.D. 1.96	S.D 1.58
AA	M 2.29	M 2.10
	S.D .35	S.D 1.52

Note. Time measured in seconds

was less than 5 seconds (See Appendix D). The mean total time latency for the last 18 difficult-to-relate word pairs was more than 5 seconds for both LD and AA students (See Appendix D). The mean total latencies associated with the 18 easy-to-relate word pairs and 18 difficult-to-relate word pairs for LD and AA students are presented in Table 2.

Table 2

Total Latency Means (M) And Standard Deviations (SD) Associated With 18 Easy And 18 Difficult Word Pairs For LD And AA Students.

Group	Easy	Difficult
LD	M 4.01	M 7.39
	S.D. 1.24	S.D 2.55
AA	M 3.51	M 6.18
	S.D .63	S.D 2.59

Note: Time measured in seconds

No significant total time differences were found between LD students ($M = 4.01s$) and AA students ($M = 3.51s$), $t(28) = 1.41$, $p > .05$ for the 18 easy-to-relate word pairs. The disparity in standard deviations shown in Table 2 for the easy-to-relate word pairs between LD and AA students was attributable to the same LD subject mentioned earlier whose mean total time was 7.55 seconds, which

was much higher than average for his group. When this student's total time score is removed, the reading time mean and standard deviation for the LD group is ($M = 3.76s$) and ($SD = .79s$). No significant total time differences were found between LD students ($M = 6.18s$) and AA students ($M = 7.39s$), $t(28) = 1.28$, $p > .05$ for the difficult-to-relate word pairs.

Experimental Study

Subjects and Design

Eighty students, 40 LD and 40 AA participated in the experimental study. The 40 students within each classification were randomly assigned to either the imagery or the control condition. Within each of the instructional conditions subjects were exposed to two paired associate lists, defined by the combination of easy versus difficult word pairs (18 each) and fast (5 sec) versus slow (10 sec) presentation rates. The presentation rates and word pairs used in this study were derived from the norming study discussed in the previous section. The results were analyzed using a 2 x 2 x 2 x 2 (group x instruction x presentation rate x pair difficulty) analysis of variance with repeated measures on the last two factors.

Procedures

Each student was randomly assigned to one of the two instructional conditions. Presentation rates were counterbalanced, such that half of the subjects in each instructional condition performed first under the 5 second rate, while the other half performed first under the 10 second rate. At the beginning of the session, all students were informed that they would be learning two lists of word pairs, and would be tested on them. Both lists were composed of nine easy and nine difficult word pairs. The order of list presentations was counterbalanced. Instructions appropriate to the student's instructional condition were provided along with two

sample items and three practice items to familiarize the student with the requirements of his instructional condition (see Appendix E for a complete description of instructions to subjects). The three practice items and the 36 word pairs used in the actual learning task were presented to the students on an Apple Macintosh (512 K) microcomputer. Following the learning phase, the student was tested for associative recall by being presented with one member of each pair and being required to recall its pairmate. Subjects were subsequently asked to report and describe the strategies they implemented to learn the word pairs. For example if the subject reported forming pictures in his mind, he was asked to describe the pictures.

All students were seen individually by a female experimenter in a quiet room in their respective schools. The total amounts of time spent with the experimenter and spent studying the word pairs were equivalent for both instructional conditions. The vocabulary sub-test of the WISC-R was administered post-hoc to each student. Each experimental session took approximately 45 minutes.

Instructional Conditions. Subjects in the *imagery condition* were instructed to learn the word pairs by forming an image of the two words "doing something with each other" in order to remember the word pair (see Appendix E). Given the word pair dog-car for example, students were asked to form a picture in their minds of a dog and a car doing something with each other. Experimenter-provided drawings were provided for two sample items to illustrate

what good interactive pictures might look like (See appendix B).

Subjects in the *rehearsal condition* were instructed to learn the word pairs by repeating the items together, essentially a rehearsal procedure (see Appendix E). Again using the example dog-car, subjects were asked to say the words dog and car over and over again, so they could remember that dog went with car and vice versa. Two sample items were provided to illustrate how the repetition method could be used.

Testing and Scoring Procedures. Students were tested for cued recall following each list presentation. The first member of the word pair was presented on the computer and the subject was asked to say the second member of the pair (see Appendix E). Each student was given up to 30 seconds to respond. After testing, all students were asked to report and describe the types of strategies they employed in learning the paired items (see Appendix E).

On the recall test, responses were scored correct (1 point) if the item was recalled verbatim or incorrect (0 points) if the student did not provide a verbatim response. The total number of points possible for each test was 18.

Subjects' reported study strategies were classified into 5 categories: *Rehearsal* (repetition of a word-pair with or without a conjunction e.g., doll and book, or doll-book); *visual imagery* (a visual image depicting a direct interaction between the the pair members, e.g., I saw a bird in a cage); *verbal elaboration* (description of a direct relation between the members not represented in an

image, e.g., knife cutting an orange); *other association* (some other type of association, other than a direct interaction of the two members of the pair, e.g., iron is hard, candy is soft, breakfast for bacon-eggs); and *no strategy* reported (e.g., when a student could not report on the strategy and maintained that he just remembered the word pairs.).

Data Analyses

A series of separate imagery-rehearsal planned comparisons were conducted within each group/presentation rate/pair difficulty combination. (See Appendix F for computation of variance components for contrasts using Satterthwaites (1946) method). A repeated measures analysis of variance was used to arrive at the error terms to be used for the comparisons. Separate imagery-rehearsal post hoc comparisons were performed within each group to determine the effect of pair difficulty. Responses regarding strategy reports were categorized and these data were subjected to descriptive analyses.

Chapter 3

RESULTS

The experimental study was designed to test the effect of rate of presentation and type of material on learning disabled and average achieving students' use of visual imagery on a paired associate learning task. The variables under investigation were group (LD vs. AA), instruction (Imagery vs. Rehearsal), presentation rate (5 secs vs. 10 secs) and pair difficulty (easy vs. difficult). The effect of these variables was measured by two 18-item recall tests. The first test was presented immediately following the first word list using either the 5 or 10 second rate, and the second test was presented after the second list using the second presentation rate. The tests consisted of presenting the stimulus words from the original lists, and the number of correctly matched responses served as the dependent variable.

The immediate recall test data were analyzed using a 2 x 2 x 2 x 2 (group x instruction x presentation rate x pair difficulty) analysis of variance, with repeated measures on the last two factors (see Appendix G for raw data). To determine whether LD students' use of the imagery strategy would be constrained by difficult-to-relate word pairs and/or when the word pairs were presented at a fast rate (5 seconds), a series of separate imagery-rehearsal planned comparisons were conducted for each presentation rate/pair difficulty combination. Pooled error terms from the repeated measures analysis of variance were used for these planned

comparisons. Strategy reports obtained through interviews were classified and descriptive statistics were computed in order to determine whether or not subjects employed the strategy they were instructed to use.

Recall Performance

The means and standard deviations of the number of items recalled as a function of group, instruction, presentation rate, and pair difficulty are presented in Table 3. Each mean represents the average number of items recalled correctly out of a maximum of 9 items. The mean performance of students in the imagery condition was uniformly higher than the mean performance of students in the rehearsal condition; easy pairs yielded higher mean scores than difficult pairs; slow rates yielded higher mean scores than fast rates; and the mean performance of LD students was slightly lower than the mean performance of AA students.

A summary of the repeated measures ANOVA is presented in Table 4. The ANOVA table shows significant main effects for instructional condition [$F(1,76) = 54.84, p < .01$], rate of presentation [$F(1,76) = 19.49, p < .01$], and pair type [$F(1,76) = 166.95, p < .01$]. The main effect for group approached significance at the .05 level [$F(1,76) = 3.65, p = .06$]. Imagery produced better learning than rehearsal; more was learned with the slower rate of presentation; easier pairs were recalled better than difficult pairs; and AA students tended to have higher recall scores than LD students.

Contrary to the original hypotheses, imagery instructions

Table 3

Means (M) And Standard Deviation (SD) Of Correct Responses As A Function of Group, Instruction, Presentation Rate And Pair Difficulty.

Group	Instruction	Easy Pairs			Difficult Pairs			
		Presentation rate						
		5 sec	10 sec	Total	5 sec	10 sec	Total	
	Imagery	M	7.40	8.20	7.80	5.10	6.20	5.65
		SD	1.82	1.32	1.57	2.29	2.12	2.21
LD	Rehearsal	M	5.05	6.00	5.52	2.15	3.00	2.58
		SD	2.29	2.20	2.25	2.06	2.75	2.41
	Imagery	M	7.55	8.25	7.90	6.25	6.95	6.60
		SD	1.73	0.97	1.35	2.99	2.31	2.65
AA	Rehearsal	M	5.80	6.90	6.35	2.75	3.85	3.30
		SD	1.64	1.61	1.63	2.17	2.30	2.24
Total			6.45	7.33	6.89	4.06	5.00	4.53

Note. Maximum score = 9 words.

Table 4

Analysis Of Variance Of Correct Responses.

Source	SS	df	MS	F
Between Subjects	1270.83	79		
A (Group)	34.45	1	34.45	3.65
B (Instruction)	517.65	1	517.65	54.84*
AB	1.37	1	.15	.70
Error	717.38	76	9.43	
Within Subjects	1152.22	240		
C (Presentation Rate)	67.53	1	67.53	19.49*
AC	.00	1	.00	.00
BC	.70	1	.70	.20
ABC	1.13	1	1.13	.33
Error	263.39	76	3.47	
D (Pair Difficulty)	448.87	1	448.87	166.95*
DA	2.63	1	2.63	.98
DB	33.15	1	33.15	12.33*
DAB	4.75	1	4.75	1.77
Error	204.33	76	2.68	
CD	.03	1	.03	.02
CDA	.08	1	.08	.05
CDB	.25	1	.25	.15
CDAB	.15	1	.15	.09
Error	125.23	76	1.65	
Total	2423.05	319		

* $p < 0.05$

yielded higher mean scores than rehearsal instruction on learning the paired associates regardless of presentation rate. As shown in Table 5, the imagery versus rehearsal difference was significant at $p < .05$ for all eight of the possible pairwise comparisons between a single imagery and its corresponding rehearsal cell that can be made given the setup used here (i.e., within each of the eight blocks defined by 2 levels of group, 2 levels of presentation rate, and 2 levels of pair difficulty).

However a significant Instruction by Difficulty interaction $F(1,76) = 12.33, p < .01$ was also found. The cell data relevant to interpreting this interaction are given in Table 6, showing the differential effect of pair difficulty for imagery and rehearsal conditions; the imagery versus rehearsal difference was larger for difficult than for easy pairs. Tests of simple main effects of instructional conditions at each difficulty level revealed significant instructional effects for both easy-to-relate [$F(1,116) = 5.93, p < .05$] and difficult-to-relate word pairs [$F(1,116) = 16.88, p < .05$]. These findings simply underscore the facilitative effect of imagery instructions. It is also clear that the effect of imagery instructions over rehearsal instructions is more pronounced for difficult-to-relate than for easy-to-relate word pairs.

Although the group by instruction by difficulty effect was not significant, the interaction described above was also tested within each group. The means representing these within group interactions were presented previously in Table 3. The resulting F tests for the

interactions within the LD and AA groups were $F(1,76) = 2.33$, $p > .05$, and $F(1,76) = 11.42$, $p < .05$. For LD students the imagery versus rehearsal difference was significant for both easy-to-relate $t(76) = 4.145$, $p < .05$, and difficult-to-relate word pairs $t(76) = 5.6$, $p < .05$. For AA students the imagery versus rehearsal difference was significant for both easy-to-relate $t(76) = 2.76$, $p < .05$ and difficult-to-relate word pairs $t(76) = 6.00$, $p < .05$. However, the imagery-rehearsal difference for easy to-relate word pairs was much smaller for the AA students than for the LD students.

Table 5

Obtained t Statistics And Critical Values For Imagery/Rehearsal Comparisons

Comparison	$\bar{x}_i - \bar{x}_j$	Obtained t statistic
For learning disabled students		
5E Imagery vs. Rehearsal	7.40 - 5.05	3.56*
5D Imagery vs. Rehearsal	5.10 - 2.15	4.47*
10E Imagery vs. Rehearsal	8.20 - 6.00	3.33*
10D Imagery vs. Rehearsal	6.20 - 3.00	4.85*
For Average Achieving Students		
5E Imagery vs. Rehearsal	7.50 - 5.80	2.57*
5D Imagery vs. Rehearsal	6.25 - 2.75	5.30*
10E Imagery vs. rehearsal	8.25 - 6.90	2.05*
10D Imagery vs. Rehearsal	6.95 - 3.85	4.69*

* $p < .05$ with critical value of $t = 1.99$, $df = 76$, two-tailed.

Note. 5 and 10 indicate presentation rate in seconds.

E = easy and D = difficult indicate levels of pair difficulty.

Table 6

Cell Data For The Instruction By Pair Difficulty Interaction

Instruction	Pair Difficulty					
	Easy		Difficult		Total	
	M	SD	M	SD	M	SD
Imagery	7.85	1.46	6.13	2.43	6.99	1.95
Rehearsal	5.94	1.95	2.94	2.32	4.44	2.13
Total	6.90	1.71	4.54	2.38	5.67	2.04

Note. Maximum score = 9.

Strategy Reports

Each subject was asked to tell what strategy he used with each of the 18 word pairs following the second trial. Unfortunately complete data was only available for 14 students out of a total of 20 students. It was expected that those in the imagery group would routinely report using imagery and those in the rehearsal groups would routinely report using rehearsal. However, not everyone reported using the strategy they were instructed to use. Table 7 shows the mean number (and standard deviation) of word pairs for which a particular strategy was used by 14 LD and 14 AA subjects.

Imagery was the most frequently reported strategy in the imagery condition. Out of 18 possible items, AA students reported using imagery more frequently ($M = 16.20$) than LD students ($M = 13.71$), $F(1,48) = 23.09$, $p < .05$. In the imagery condition, the mean proportion of items that were recalled correctly by AA and LD students, after using imagery, was .92 and .87 respectively.

Rehearsal was the most frequently reported strategy in the rehearsal condition. The difference between the mean number of items for which rehearsal was used by both LD ($M = 12.64$) and AA ($M = 11.15$) students was not statistically significant $F(1,48) = 1.99$, $p > .05$. The mean proportion of items recalled correctly by LD and AA students, after using the rehearsal strategy, was only .44 and .53 respectively.

Table 7
Means (M) and Standard Deviations (SD) Of Reported Strategies
As A Function Of Group And Instructional Condition

Condition	Reported Strategy	LD		AA	
		M	SD	M	SD
Imagery	Imagery	13.71	1.93	16.20	1.41
	Rehearsal	.37	.09	0.00	0.00
	Verbal Elaboration	1.84	.94	0.76	.46
	Other Association	.74	.25	.48	.09
	No Strategy	1.34	.82	.56	.47
Rehearsal	Imagery	.37	.09	1.29	.09
	Rehearsal	12.64	2.91	11.50	2.41
	Verbal Elaboration	2.61	1.55	4.44	1.77
	Other Association	1.51	.90	.77	.55
	No Strategy	.87	.32	0.00	0.00

Note. Maximum score = 18

Verbal elaboration was the second most frequently reported strategy in the rehearsal condition by LD ($M= 2.61$) and AA students ($M= 4.44$). The mean proportion of items recalled correctly using the verbal elaboration strategy was .93 for LD students and .94 for AA students. Verbal elaboration was used more frequently for easy-to-relate than difficult-to-relate word pairs. The mean number of easy-to-relate items for which verbal elaboration was used by LD and AA students was ($M= 2.11$) and ($M= 4.00$) respectively. The mean number of difficult-to-relate items for which verbal elaboration was used by LD and AA students was ($M= .50$) and ($M = .44$) respectively.

Chapter 4

SUMMARY, DISCUSSION AND CONCLUSIONS

This chapter includes a summary, discussion, and conclusion of the purposes and findings of the present investigation. The results will be discussed in light of some of the major principles of cognitive strategy instruction that pertain to person, task, and situational factors.

Summary

The present investigation was a two-phase study which examined the effects of rate of presentation and type of material on AA and LD students' use of self-generated imaginal elaboration instructions. The first phase, a norming study, was designed to generate empirically a list of easy and difficult word pairs and two rates of presentation to be used in the experimental study. The experimental design, employed in the second phase, evaluated the degree to which LD and AA students benefited from imagery and rehearsal instructions, with easy and difficult word pairs, under fast and slow rates of presentation. A series of separate imagery/rehearsal planned comparisons were conducted for each level of group/presentation rate/pair difficulty. Imagery-rehearsal differences were significant among LD and AA students at both presentation rates, for both easy and difficult word pairs. In particular, imagery instructions produced more facilitation with difficult-to-relate word pairs than with easy to relate-word pairs.

Discussion

The present results add to recent studies which show that self-generated imagery instructions improve LD students' performance on tasks that have associative components (Mastropieri et al., 1985; McLoone et al., 1986; Elliott & Gentile, 1986). Specifically, this study examined the possibility that difficult material and fast rates of presentation, which constrained the utility of imagery instructions for younger AA students in previous studies, may also be evident with LD students in the present study.

As described earlier, it was hypothesized that LD students would only be able to benefit from imagery instruction with easy-to-relate pairs and/or when the word pairs are presented at a relatively slow rate. However, contrary to this expectation, was the striking and clear finding that recall rates for LD students did not suffer under fast rates of presentation and/or with difficult word pairs. Imagery effects were robust with respect to rate of presentation and word-pair difficulty for both LD and AA students.

Although the mean performance of LD students was somewhat lower than the mean performance of AA students, the patterns of performance differences as a function of instruction, rate, and pair difficulty were virtually identical to the AA students. Thus, on the one hand these data do not support the hypothesis that LD students will have difficulty in the use of imagery based learning strategies. On the other hand, these data provide complimentary evidence to what Pressley and his associates have been arguing, that by the end

of the grade school years students can generate imaginal elaborations for verbal, unrelated materials that are presented at rapid rates.

These results are consistent with Rohwer et al's. (1982) finding that prompt instructions produce more facilitation for low-accessibility (difficult-to-relate) word pairs. The smaller imagery-rehearsal differences for easy-to-relate word pairs than for difficult-to-relate word pairs suggest that perhaps easy-to-relate word pairs are automatically elaborated, and consequently do not require elaboration instructions (Rohwer et al., 1982). According to Rohwer et al. (1982), elaboration of easy-to-relate word pairs requires only that subjects locate in their knowledge base events that overlap with the presented items. This information is easily accessed, more so than for difficult word pairs. Consistent with this interpretation, students in the rehearsal condition reported more verbal elaboration strategies for easy-to-relate word pairs than for difficult-to-relate word pairs. It is worth mentioning, however, that smaller imagery-rehearsal differences were obtained for AA students than for LD students for easy-to-relate word pairs. Perhaps, unlike the LD students, AA students had more relevant knowledge events that fully overlapped with the easy-to-relate word pairs that were presented. Consequently, imagery instructions produced more facilitation for LD students than AA students for easy-to-relate word pairs.

Strategy reports obtained from the students indicated that generally students did use the strategy they were instructed to use.

However, there were differences between the mean number of items for which strategies were reported by LD and AA students. Imagery was the most frequently reported strategy by LD and AA students in the imagery condition, but LD students reported using imagery with fewer items than AA students. This discrepancy may in part explain the lower mean scores by the LD subjects on the recall of paired associate word pairs.

Although rehearsal was the most frequently reported strategy by both LD and AA students in the rehearsal condition, the mean proportion of items that were recalled correctly by LD and AA students was only .44 and .53 respectively. These findings lend support to the claim that rehearsal strategies do not constitute effective strategies for paired-associate tasks (Pressley & Levin, 1987; Rohwer, 1973). Furthermore, even though the second most frequently reported strategy in the rehearsal condition was verbal elaboration, the mean proportion of items that were recalled correctly using the elaboration strategy was higher than the mean proportion of items that were recalled correctly using the rehearsal strategy. These findings suggest that perhaps AA and LD students have the potential to use effective strategies spontaneously and to learn at a very high level if they did so.

Conclusions and Implications

The effects of task, person, and situational factors on the use of self-generated imagery strategy instructions were empirically investigated under carefully controlled conditions. The results of this

fine-grained investigation provide conclusive evidence that the self-generated imagery strategy instruction has positive effects on both LD and AA students' learning. Importantly, LD students could meet the information processing demands of the imagery strategy even under difficult conditions. The success of the imagery strategy in facilitating paired-associate learning of LD and AA students supports the theory that students' active involvement in the learning process has a positive effect on learning. Moreover, the results of this study suggest that the disability LD students exhibit in verbal associative tasks seems quite modifiable thorough minimal self-generated imagery instruction.

Suggestions for Further Research

In this study an immediate recall test was used but it would be informative in subsequent research to use a delayed recall test as well. A delayed recall test would be useful in assessing the long term effects of the visual imagery strategy with LD and AA students.

In the present investigation a generous amount of time (30 seconds) was afforded to students to respond. Under these time conditions students were able to carry out the decoding-processing requirements associated with visual imagery. Whether or not the strategy would prove similarly effective, under test conditions allowing less time, is a question that needs to be addressed.

Data from the strategy reports reveal that both LD and AA students in the rehearsal condition reported spontaneous use of verbal elaboration. The small but significant imagery/rehearsal

differences for easy-to-relate word pairs may be attributed to more frequent use of verbal elaboration for these pairs. Verbal elaboration strategies were less frequently reported for difficult-to-relate word pairs. It may have been that elaborative activity was impeded by asking students to repetitiously rehearse each pair or that students just simply could not spontaneously elaborate difficult-to-relate word pairs. The inclusion of a control condition in which subjects are allowed to use their own strategy would allow for a more critical evaluation of the extent to which LD and AA students benefit from imagery instruction.

Researchers have contended that until the end of the elementary school years AA students' use of imaginal elaborations is degraded by fast rates of presentation and/or difficult materials (Pressley, 1982; Schneider & Pressley, 1989). In the current investigation sixth and seventh grade learning disabled students' pattern of performance differences as a function of instruction, rate, and pair difficulty were virtually identical to AA students. Students were able to generate interactive images under a fairly rapid rate with difficult-to-relate materials. By replicating this design, future research studies could investigate whether or not younger LD students' use of imaginal strategies follow a complex developmental pattern similar to younger AA students.

Instructions to generate imaginal elaborations facilitated paired-associate learning in LD and AA students in a controlled one-to-one setting. Whether or not students can benefit from

instructions to use the strategy in a classroom setting, with teachers and groups of students, is a question for future study.

An eventual goal is to facilitate LD students' spontaneous use of effective and appropriate strategies. An important question to be asked is whether minimal strategy instruction, with LD students, is enough to facilitate transfer of strategies to a new task in which the strategies might be helpful.

The results of the present investigation reveal that LD students can use the self-generated imagery strategy for remembering paired associates. However, the full potential of self-generated imagery strategies with LD students needs to be evaluated with other school-learning activities apart from those which entail paired-associate components. It would be important to explore whether or not the self-generated imagery strategy will enhance LD students' recall of difficult-to-remember content from prose passages.

Implications for Practitioners

The findings of this research have implications for increasing learning of educational content with associative components. Much of what students learn and are tested on in school include tasks with factual knowledge components and knowledge of relationships between components of information. Learning of vocabulary-definitions, science classifications (e.g., minerals and hardness levels), and social studies facts (e.g., states and capitals, provinces and their commodities) are examples of such tasks. By instructing both LD and AA students to create meaningful relationships between the to-be-

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learned information, especially difficult-to-relate materials, teachers can increase associative recall of students. Instruction in imaginal elaborations is particularly relevant to LD students since they exhibit deficiencies in learning verbal associates. A major strength of these strategies is that they can facilitate LD students' associative learning with minimal instruction.

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APPENDIX A

Parent/Guardian Consent Form

APPENDIX A

COLLEGE OF EDUCATION



VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Blacksburg, Virginia 24061

INSTITUTE FOR THE STUDY OF EXCEPTIONALITIES

Parent/ Guardian consent form

This is to certify that I, _____, parent or legal guardian of _____ have read and understand the procedures outlined below, and give permission to have my child participate in the study being conducted by Susan Ferro, M.Ed, Lawrence Cross, Ph.D., and Terry Wildman, Ph.D., of Virginia Polytechnic and State University. The study will involve the comparison of different study strategies for children with and without learning problems. The procedures to be followed are:

1. Achievement and intellectual measures will be obtained from the child's school records.
2. Children will participate in a procedure which will involve being presented with a list of words on a computer, and will be expected to learn the list using a study strategy.
3. The study will be conducted during school hours.

Information about your child and his performance will remain confidential, only individuals working on this project will have access to this information. You are free, as is your child to withdraw consent at any time for any reason.

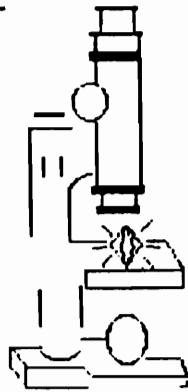
 Signature of parent or guardian

Date

APPENDIX B

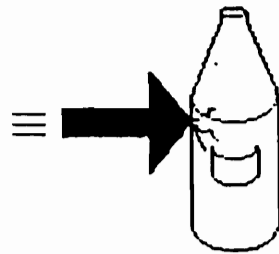
Experimenter-Provided Examples Of Images

MICROSCOPE



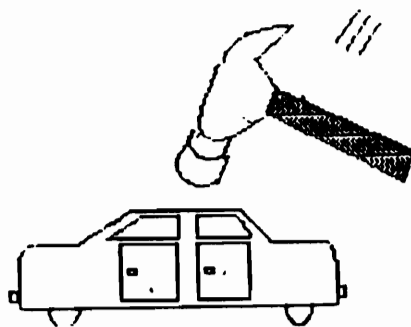
DIAMOND

ARROW



BOTTLE

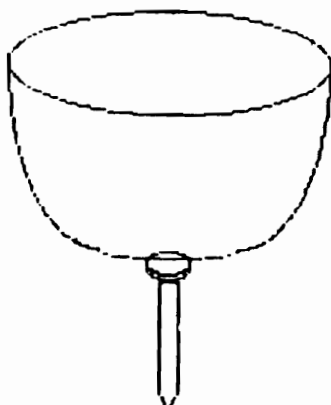
CAR



HAMMER

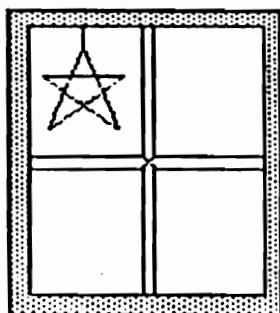
NAIL

BOWL



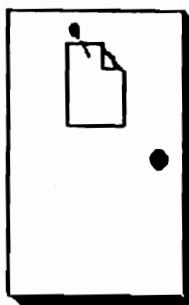
STAR

WINDOW



DOOR

PAPER



APPENDIX C

Examiner's Script For The Norming Study

APPENDIX C

Examiner's Script For The Norming Study

I am going to show you a list of word pairs on the computer. When I say "word pair" I mean two words, like dog-bicycle. We are going to play a little game. Each time I show you a word pair I would like you to try and form a picture in your head of the two words doing something with each other. For example, for the word pair dog-bicycle you could form a picture of a dog riding a bicycle. It is important that your picture shows the two words doing something with each other, instead of just seeing them side by side. Do you understand this?

Good. Now let's practice forming pictures. What picture would you form if I gave you the word pair microscope-diamond? (After subject responds, provide feedback by showing the picture of the diamond under the microscope). What picture would you form if I showed you the word pair arrow-bottle? (After subject responds, provide feedback by showing the picture of the arrow hitting the bottle).

Now I am going to show you the word pairs on the screen. Before you form a picture I want you first to read the word pair aloud to me and then form a picture. After you form the picture I want you to press this button like this (press button on mouse). Go ahead, try pressing the button. Good. I will ask you to tell me about the picture you formed. Do you understand? O.K. so what are you

going to do when you see the word pair on the screen? (Subject describes what he has to do. Provide necessary feedback if he is wrong, and ask the question again).

Now lets practice. I am going to show you only three word pairs one at a time. Don't forget to read the word pair, form a picture in your head of the two words doing something with each other, and press the button as soon as you form the picture. Are you ready? (show the three word pairs car-hammer, nail-bowl, and star-window one at a time). After subject has read the word pairs, formed the images, and reported the images, show him pictures of the three word pairs as examples.

Now I am going to show you the entire list of word pairs. Are you ready? (Show each word pair, after subject reads the word pair and presses the button, ask the subject to describe the image he formed). Can you describe to me the picture you formed? (On completion of the task the subject will be thanked for his participation in the study). Thank you for your participation.

APPENDIX D

Final List Of 18 Easy and 18 Difficult Word Pairs

APPENDIX D

Final List Of 18 Easy And 18 Difficult Word Pairs.

18 Easy Word Pairs

WORD PAIRS	LD			AA		
	TT	RT	IT	TT	RT	IT
Milk-Bowl	4.00	2.38	1.61	3.56	2.00	1.56
Button-Needle	4.12	1.55	2.55	4.10	2.22	1.88
Knife-Orange	4.39	2.43	1.96	3.72	2.14	1.58
Eggs-Bacon	3.98	1.96	1.92	3.40	1.96	1.44
Bird-Cage	4.78	3.09	1.69	3.29	2.12	1.17
Elephant -Banana	4.76	2.75	2.01	4.36	2.19	2.90
Flower-Hat	4.84	3.04	1.80	3.45	2.15	1.30
Hammer-Nail	4.92	3.25	1.67	3.90	1.95	1.95
Moon-Sky	4.15	2.30	1.85	3.12	2.14	.98
Lion-Jungle	3.80	2.39	1.41	2.98	2.12	.86
Bell-Church	3.10	2.05	1.05	3.36	1.99	1.37
Ax-Wood	3.98	2.38	1.6	4.00	3.12	.88
Stamp-Letter	3.93	2.57	1.33	2.73	2.03	.70
Bread-Butter	3.53	2.00	1.53	2.78	2.00	.78
Rain-Cloud	3.51	2.13	1.39	3.72	1.18	2.54
Blanket-Bed	3.14	1.91	1.23	3.55	2.32	1.23
Boat-Lake	3.30	1.87	1.43	3.73	2.22	1.51
Snow-Shovel	4.09	2.67	1.42	3.58	1.84	1.74

18 Difficult Word Pairs

WORD PAIRS	LD			NA		
	TT	RT	IT	TT	RT	IT
Fan-Pill	10.00	3.40	6.60	7.45	2.48	4.98
Door-Heart	8.91	3.76	5.15	6.65	2.17	4.48
Soap-Donkey	8.55	3.91	4.94	5.48	2.30	3.18
Candle-Lemon	8.79	3.09	5.70	6.20	2.82	3.90
Dice-Cane	8.23	4.25	3.98	6.06	2.36	3.70
Ring-Chalkboard	7.79	3.93	3.86	8.36	2.53	5.83
Doll-Book	7.70	3.26	4.44	6.20	2.64	3.56
Key-Stone	7.31	2.90	4.43	5.44	2.30	3.14
Computer-Elbow	7.28	2.91	4.38	5.23	2.40	2.27
Iron-Candy	7.17	2.70	4.47	6.00	2.44	1.69
Ruler-Sandwich	6.62	3.58	3.04	5.00	2.75	2.25
Rug-Zebra	6.22	3.25	2.98	5.33	2.12	3.21
Lobster-Bus	5.98	3.06	2.92	7.28	2.60	2.26
Foot-House	5.83	2.75	3.08	5.05	2.13	2.92
Rope-Eye	5.37	2.85	2.53	6.62	2.57	3.05
Wheel-Thumb	6.47	3.27	3.20	5.04	2.40	2.64
Bathtub-Swing	7.42	3.85	3.47	7.00	2.55	4.45
Tractor-Mask	7.42	3.38	4.04	7.00	2.89	4.11

APPENDIX E

Examiner's Script For The Experimental Study

APPENDIX E

Examiner's Script For The Experimental Study

General Instructions to Students

We are going to play a little game. I am going to show you a list of word pairs on the computer. When I say "word pair" I mean two words for example **apple ball**. I am also going to teach you a method to learn that the two words go together so that if I show you only one word, you will be able to tell me what word went with it. I would like you to help me find out if this method which I am going to teach you will help you. Are you ready?

Instructions to Students in the Imagery Condition

As I show you each word pair on the computer I want you to read it aloud to me, then I want you to form a picture in your head of the two things doing something with each other. For example if I show you the word pair **Arrow Bottle** (show the word pair to the student), I want you to read the word pair **Arrow Bottle** aloud, and then you could form a picture in your head like this one (show picture of arrow hitting the bottle) of the **Arrow** hitting the **Bottle**. Now if I only show you the word **Arrow**, I want you to think back to the picture to help you to come up with the word **Bottle**. Lets look at a another word pair (show word pair), I want you to say **Paper Door**, then you could form a picture in your head like this one (show picture) of the **Paper** pinned to the **Door**. Now if I only show you the word **Paper**, all you have to do is to think back to your picture

so that you can come up with the word **Door**. Do you understand this?

Now let me give you a little practice. I am going to show you only three word pairs. Just read each of them aloud, form a picture in your head of the two words doing something with each other and keep the picture in your head. (Show the three word pairs, CAR HAMMER, NAIL BOWL, and STAR WINDOW). Now I am only going to show you one side of the word pair and I want you to think back to the picture you formed. This will help you to tell me what word went with it. Are you ready? (Show one side of each word and ask student to provide the answer, also ask the student for the picture he formed. If the student does not report good interactive pictures, provide student with examples of interactive pictures).

Now I am going to show you a list of paired words and I want you to form pictures in your head for each of these word pairs. After I show you the entire list I am going to give you a test. It will be like the test I gave you in the practice trial. I will show you one side of the word pair and you need to tell me the word that went with it. Are you Ready? (go through entire list and test the student using the testing instructions).

(Following testing, after the first trial, provide the student with the second list and say). Now I am going to show you the second list of word pairs and I want you to use the same method to learn the word pairs. Again, after I show you the entire list I will give you a test like I did the last time. Are you ready? (show students the

entire list, test students and then ask them the interview questions)

Test Instructions

Now I am going to show you the first word of each pair and I want you to think back to the picture you formed. The picture will help you to come up with the word that went with the word you see on the screen. Are you ready? (show the entire list).

Instructions to Students in the Rehearsal Condition

As I show you each word pair on the computer I want you to read it aloud to me, then I want you to say the words over and over. For example, if I show you the word **Arrow Bottle** (show the word pair to the student), I want you to read the word pair **Arrow Bottle** aloud, and then say it over and over in your head. Now if I only show you the word **Arrow**, I want you think back to the word that went with it. Lets look at a another word pair (show word pair), I want you to read **Paper Door** aloud, then you need to say it over and over. Now if I only show you the word **Paper**, all you have to do is to think back to the word that went with it. Do you understand this?

Now let me give you a little practice. I am going to show you only three word pairs. Just read each of them aloud and say them over in your mind O. K? (show the three word pairs one after the other). Now I am only going to show you one side of the word pair and I want you to tell me what word went with it. Are you ready? (Show one side of each word and ask student to provide the answer).

Now lets try and study the first list of word pairs using the method I taught you. Are you ready?

(Following testing students after the first trial provide the student with the second list and say). Now I am going to show you the second list of word pairs and I want you to use the same method to learn the word pairs. Again, after I show you the entire list I will give you a test like I did the last time. Are you ready? (show students the entire list, test students and then ask them the interview questions)

Test Instructions

Now I am going to show you the first word of each pair and I want you to think back to the word that went with the word you see on the screen. Are you ready? (show the entire list)

Interview Questions for Students in Both Conditions

(Immediately after testing students on the second trial go back to the top of the list and for each word pair ask the student the following questions):

1. What did you do to learn this word pair?
2. Did you do anything else?

APPENDIX F

Computation Of Variances For Contrasts

APPENDIX F

Computation Of Variances For Contrasts

Model: $Y_{ijklm} = \mu_{ijm} + f_{ijk} + g_{ijkl} + h_{ijklm} + \epsilon_{ijklm}$

$i = 1, 2$ Factor A (Imagery, Control).

$j = 1, 2$ Factor B (LD, AA).

$k = 1, 2$ 20 Subject

$L = 1, 2$ Factor C (5sec, 10sec)

$m = 1, 2$ Factor D (Easy, Difficult).

Contrast of Interest:

$\bar{Y}_{11..11} - \bar{Y}_{12..11}$ (contrasts a between interaction for one combination of the within factor).

$$\begin{aligned} \bar{Y}_{11..11} - \bar{Y}_{12..11} &= \mu_{11..11} - \mu_{12..11} + \bar{f}_{11.} - \bar{f}_{12.} \\ &\quad + \bar{g}_{11..1} - \bar{g}_{12..1} \\ &\quad + \bar{h}_{11..1} - \bar{h}_{12..1} \\ &\quad + \bar{\epsilon}_{11..11} - \bar{\epsilon}_{12..11} \end{aligned}$$

② See computation of Expected Mean Squares on SAS printout (next page).

$$\textcircled{3} \quad V(\bar{Y}_{1111} - \bar{Y}_{1211}) = (V(\bar{f}_{111} - \bar{f}_{121}) + V(\bar{g}_{1111} - \bar{g}_{1211}) \\ + V(\bar{h}_{1111} - \bar{h}_{1211}) + V(\bar{E}_{1111} - \bar{E}_{1211}))$$

$$\hat{V}(\bar{f}_{111} - \bar{f}_{121}) = \frac{2}{\omega_0} \hat{\sigma}^2 f_{ijk}$$

$$\hat{V}(\bar{g}_{1111} - \bar{g}_{1211}) = \frac{2}{\omega_0} \hat{\sigma}^2 g_{ijkl}$$

$$\hat{V}(\bar{h}_{1111} - \bar{h}_{1211}) = \frac{2}{\omega_0} \hat{\sigma}^2 h_{ijklm}$$

$$\hat{V}(\bar{E}_{1111} - \bar{E}_{1211}) = \frac{2}{\omega_0} \hat{\sigma}^2 E_{ijklm}$$

$$\text{So } \hat{V}(\bar{Y}_{1111} - \bar{Y}_{1211}) = \frac{2}{\omega_0} [\hat{\sigma}^2 f_{ijk} + \hat{\sigma}^2 g_{ijkl} + \\ \hat{\sigma}^2 h_{ijklm} + \hat{\sigma}^2 E_{ijklm}]$$

④ To estimate these quantities use the expected mean squares

$$E[MS_{\text{Error}}] = \sigma^2 E_{ijklm}$$

$$E[MS_{C \times \text{SUB}(A \times B)}] = \sigma^2 E_{ijklm} + 2\sigma^2 g_{ijkl}$$

$$E[MS_{D \times \text{SUB}(A \times B)}] = \sigma^2 E_{ijklm} + 2\sigma^2 h_{ijklm}$$

$$E[MS_{\text{SUB}(A \times B)}] = \sigma^2 E_{ijklm} + 2\sigma^2 g_{ijkl} + 2\sigma^2 h_{ijklm} \\ + 4\sigma^2 f_{ijk}$$

$$\text{So } \hat{\sigma}^2 E = MS_{\text{Error}}$$

$$\hat{\sigma}^2 g_{ijkl} = \frac{1}{2} [MS_{C \times \text{SUB}(A \times B)} - MS_{\text{Error}}]$$

$$\hat{\sigma}^2 h_{ijkl} = \frac{1}{2} [MS_{D \times \text{SUB}(A \times B)} - MS_{\text{Error}}]$$

$$\hat{\sigma}^2 f_{ijk} = \frac{1}{4} [MS_{\text{SUB}(A \times B)} - MS_{D \times \text{SUB}(A \times B)} - MS_{\text{Error}}] \\ - (MS_{C \times \text{SUB}(A \times B)} - MS_{\text{Error}}) - MS_{\text{Error}}$$

$$\textcircled{5} \text{ Then } \hat{V}(\bar{Y}_{11111} - \bar{Y}_{12111}) = \frac{1}{10} [MS_{\text{error}} + \frac{1}{2} (MS_{C \times \text{SUB}(A \times B)} - MS_{\text{error}}) + \frac{1}{2} (MS_{D \times \text{SUB}(A \times B)} - MS_{\text{error}}) + \frac{1}{2} (MS_{\text{SUB}(A \times B)} - MS_{C \times \text{SUB}(A \times B)} - MS_{D \times \text{SUB}(A \times B)} + MS_{\text{error}})]$$

$$= \frac{1}{40} [MS_{\text{error}} + MS_{C \times \text{SUB}(A \times B)} + MS_{D \times \text{SUB}(A \times B)}]$$

APPENDIX G

Raw Data For Experimental Study

APPENDIX G

Raw Data For Experimental Study

LD Imagery

Subject Number	5E	5D	10E	10D
1	6	5	8	2
2	8	7	9	6
3	9	9	9	8
4	8	1	8	4
5	9	7	6	6
6	9	3	9	7
7	6	5	7	7
8	8	7	9	9
9	9	6	9	8
10	2	1	4	4
11	5	7	9	8
12	7	5	8	3
13	9	3	9	8
14	7	5	7	6
15	8	2	8	4
16	8	6	9	8
17	5	3	9	9
18	8	5	9	8
19	8	8	9	5
20	9	7	9	4

AA Imagery

Subject Number	5E	5D	10E	10D
21	5	4	9	7
22	4	0	8	3
23	7	7	8	8
24	9	9	9	9
25	4	0	7	7
26	9	8	9	8
27	7	9	9	9
28	9	9	8	9
29	9	9	7	7
30	8	8	6	3
31	9	7	8	7
32	8	7	9	9
33	9	3	7	9
34	7	7	9	7
35	9	8	9	9
36	8	4	9	2
37	5	2	9	8
38	9	9	9	8
39	8	8	9	7
40	8	7	7	3

LD Rehearsal

Subject Number	5E	5D	10E	10D
41	8	5	7	8
42	2	0	4	0
43	7	0	7	4
44	5	1	1	0
45	5	4	7	1
46	5	0	4	2
47	4	2	6	3
48	4	2	8	5
49	5	1	8	5
50	6	1	5	0
51	4	0	6	1
52	8	3	7	1
53	7	5	9	5
54	8	6	9	9
55	4	6	8	7
56	3	0	3	2
57	7	3	8	3
58	3	1	5	3
59	5	2	5	0
60	1	1	3	1

AA Rehearsal

Subject Number	5E	5D	10E	10D
61	5	0	8	5
62	7	3	7	2
63	6	1	7	1
64	9	7	8	7
65	3	1	5	2
66	3	3	9	5
67	8	5	9	4
68	5	1	7	2
69	8	3	8	1
70	4	0	4	4
71	5	0	6	5
72	6	2	7	1
73	5	3	9	9
74	6	4	7	5
75	4	1	8	2
76	5	1	5	4
77	7	5	6	7
78	6	6	4	5
79	7	3	6	1
80	7	6	9	5

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EDUCATION

- PH. D.
July 1990 Virginia Polytechnic Institute and State University
(VPI & SU), Blacksburg, Virginia.
Double Major: 1. Educational Research & Evaluation
2. Educational Psychology
Minor: Psychology.
- M. Ed., 1986 Virginia Polytechnic Institute and State University,
Blacksburg, Virginia.
Major: Counseling
Minors: Sociology and Psychology
- 1983 Alliance Francais Institute, Ahmedabad, India.
Diploma for Introductory French
- B. A., 1982 Sophia College/St. Xaviers College,
Ahmedabad, India.
Major: Psychology
Minor: English Literature and Economics

PROFESSIONAL EXPERIENCE

Teaching Experience

- Jan. 1989-May. 1989 **Graduate Teaching Assistant**, College of Education,
Virginia Tech.
• Instructed an undergraduate course offered by the
Division of Curriculum and Instruction titled
"Psychological Foundations of Education".
- Aug. 1987-July, 1988 **Graduate Teaching Assistant**, College of Education,
Virginia Tech.
• Taught word processing component of a study skills
course offered by the Division of Curriculum and
Instruction titled "College Success Strategies".

Research Experience

June 1989-July 1990

Graduate Research Assistant, Institute for the Study of Exceptionalities, VPI & SU:

- participation in special education workshops.
- data collection and analysis.
- designing evaluation instruments.
- writing evaluation reports.

Research assistant for the Virginia Special Education Technical Assistance Center, VPI & SU:

- providing technical assistance to school districts in the evaluation of their special education programs.

August 1988-May 1989

Graduate Research Assistant, Virginia's Colleague Teacher Program & Beginning Special Educators' Project, VPI & SU:

- assisted in program development
- assisted in planning workshops for teachers
- data collections and analysis
- assisted with presentations and publication of technical reports

July 1988-Aug. 1988

Graduate Research Assistant, Institute for the Study of Exceptionalities VPI & SU:

- participated in special education workshops
- data collection and analysis
- designed evaluation instruments
- wrote evaluation reports

August 1987-July 1988

Graduate Research Assistant, Office of the University Provost, VPI & SU:

- conducted a needs assessment of high-risk white and all minority undergraduates at Virginia Tech.

Graduate Research Assistant, Educational Research (College of Education) at VPI & SU:

- needs assessment and a telephone survey of parental satisfaction for a local school system.

Other

June 1987-August 1987

Senior Dormitory Counselor, Upward Bound Program, VPI & SU:

- coordinated and supervised student personnel aspects of the dormitory operations

August 1986-June 1987 **Graduate Assistant**, Office of the University Provost, VPI & SU:

- academic advisor for incoming high-risk white and minority freshman

SCHOLARSHIPS AND ACADEMIC HONORS

Instructional Fee Scholarship (Fall-1989)
 Instructional Fee Scholarship (Fall-1988)
 Instructional Fee Scholarship (Spring-1987)

Virginia Polytechnic Institute and State University Graduate Student Assembly Travel Fund Award (Spring-1988)

Gujarat University Scholarship Award (1982) for ranking fifth in the University at the final third year Bachelor of Arts examination. Scholarship entailed a monetary award towards pursuing a M.A. in the same University.

GRANTS

<u>Funded</u>	<u>Amount</u>
Ferro, S. C. Effect of rate of presentation on recall using imagery. Funded by the College of Education, Aug. 89-Dec.89.	\$300.00
Ferro, S. C. Factors affecting the efficacy of imagery Instruction With learning Disabled & non-learning disabled Students. Funded by College of Education, Jan. 90-May 90.	\$300.00
<u>Unfunded</u>	
Ferro, S. C. Factors affecting the efficacy of imagery instruction with learning disabled & non-learning disabled students. Submitted to U.S. Dept. of Education.	\$10,981.00

PRESENTATIONS

International & National

Magliaro, S. G., Wildman, T. M., McLaughlin, R. A., Niles, J. A., & Ferro, S. C. (1989 March). Modeling the transition from novice to expert: A three year study of teacher problem solving. Paper presented at the annual meeting of the American Educational Research Association, San Francisco, CA.

Ferro, S. C., & Weller, H. G. (1988). Effect of presentation rate on immediate recall of nouns using imagery. Paper presented at the annual meeting of the International Visual Literacy Association, Blacksburg, VA.

Ferro, S. C., Giddings, R., McLaughlin, G., Williams-Green, J. & Giles, M. (1988 March). Assessing Institutional Effectiveness and Student Satisfaction. Presentation at the National Association for Developmental Education, Orlando, FL.

Regional Conferences

Magliaro, S. G., Wildman, T. M., Ferro, S. C., Niles, J. A., & McLaughlin, R. A. (February, 1990). Profiles of Experts: Expert Teachers' Concerns about Teaching. Paper presented at the annual meeting of the Eastern Educational Research Association, Clearwater, Florida.

McLaughlin, J. A., Ferro, S. C., McBee, J. (1989, Aug.). Annual Report of the West Virginia Evaluation Training Program. Presented at the West Virginia State Education Conference, Charleston, West Virginia.

Garrison, J. W. & Ferro, S. C. (1989, Feb.). Imagistic versus propositional theories & mental representation: Using the philosophy of science to evaluate competing research. Paper presented at the annual meeting of the Eastern Education Research Association, Savannah, GA.

Ferro, S. C., Weller, H. G., & Franchina, J. J. (1989, Feb.). Effect of imagery, rate of presentation, & study time on recall of concrete nouns. Paper presented at the annual meeting of the Eastern Educational Research Association, Savannah, GA.

Magliaro, S. G., Wildman, T. M., & Ferro, S. C. (1989, Feb.). Beginning teachers' problems and attempted solutions: Development of a three-year data base. Paper presented at the annual meeting of the Eastern Educational Research Association, Savannah, GA.

Ferro, S. C. & Wildman, T. M. (1988, Feb.). Mnemonics: A robust tool for learning about memory. Paper presented at the annual meeting of the Eastern Educational Research Association, Miami Beach, FL.

PUBLICATIONS

Ferro, S. C. & Weller, H. G. (1989). The effect of presentation rate on the immediate recall of concrete nouns using imagery. In R. A. Braden, D. G. Beauchamp, V. W. Braden & D. M. Mike (Ed.), About Visuals: Research, Teaching & Application (pp. 143-150). Blacksburg, VA: International Visual Literacy Association.

PROFESSIONAL SERVICES/AFFILIATIONS

Session chair, Eastern Educational Research Association Conference, 1989

Session chair, International Visual Literacy Association Conference, 1989

Consultant, assisted the associate director for special education programs at the Virginia State Department of Education in preparing a report for the General Assembly (November, 1989).

Member, American Educational Research Association.

Member, Council for Learning Disabilities.