

THE EFFECTS OF IMAGERY REHEARSAL STRATEGY
AND COGNITIVE STYLE ON THE LEARNING OF DIFFERENT
LEVELS OF INSTRUCTIONAL OBJECTIVES

by

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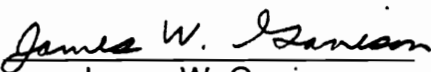
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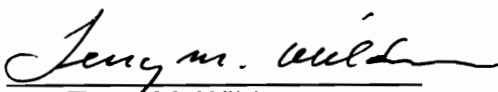
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(ABSTRACT)

This study examined the effects of different imagery strategies and the cognitive style field dependence on the learning of different levels of instructional objectives. One hundred thirteen (113) college students from six (6) intact college classes participated. All students were given the Group Embedded Figures Test to determine their level of field dependence-independence. One of three treatments, mental images recreated from a previously presented visual, self-generated imagery from an audio presentation; and a control group, which received no instructions to use imagery, was randomly assigned to each intact group. The content of the lesson consisted of the Dwyer (1967) Experimental Instructional Materials. The dependent measures were five criterion tests designed by Dwyer (1967) to measure different levels of instructional objectives. Data was analyzed using a series of two-way Analysis of Variance procedures with type of imagery and cognitive style as independent variables and the five criterion tests as dependent variables.

The results of this study indicate that there was no difference in the amount of learning when imagery was used as a rehearsal strategy for four of the five dependent measures; however, on the fifth test, the Identification Test, the use of self-generated imagery was less effective as a rehearsal strategy than either the recreated imagery strategy or the control group strategy.

On four of the five dependent measures those students who were identified as field-independent demonstrated the anticipated higher level of learning when compared to the field-dependent students. However, on the fifth test, the Identification Test, field-dependent students performed as well as field-independent students. Imagery and cognitive style did not interact.

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Chapter I

INTRODUCTION

In recent research, imagery has been explored as an instructional strategy. This imagery research has focused on the related issue of how visual information is represented in human memory. There are several schools of thought on the cognitive processes underlying the encoding, storage and retrieval of visual information. Much of the contemporary research rests on one of two theoretical foundations: Paivio's (1971, 1986) dual-coding theory and the verbal loop theory or single-coding theory (Dwyer, 1987).

Paivio's theory is based on the "coding redundancy hypothesis." In more direct terms, it is hypothesized that memory performance increases directly with the number of alternative memory codes available. Pictures may be implicitly named or described when they are presented and therefore will receive both imaginal and verbal representations in memory. This "dual coding" would enhance subsequent performance in tests of retention; if one memory track was forgotten during the retention interval, the other one might not be lost (Paivio, 1971; Richardson, 1980).

The verbal-loop theory or single information processing system hypothesizes that visual information is translated and stored as verbal/symbolic information. When this information is needed, it is translated from the stored verbal/symbolic form into the visualization form. The visualized form may not be the same as the original because of the propositional nature of the storage mechanisms (Dwyer, 1987).

Using either the "dual-coding theory" or the single coding theory as a foundation, many researchers have explored the implications of various visual instructional strategies on the learning of visual as well as verbal information. One consistent finding is that visual stimuli when used in combination with verbal information enhances learning and memory when compared to verbal only communications (Fleming & Levie, 1978; Paivio, 1986; Pressley, 1976).

In several recent studies, the use of mental imagery as a learning strategy has been shown to be as effective as the use of visuals when the task and objectives remain identical (Finke, 1980; Hanley, 1988; James, 1989; Joseph, 1987). Many researchers such as Finke (1980), Kosslyn (1981), Paivio (1986), and Shepard and Cooper (1982) have reported evidence that substantially supports the position that "...visual images have many of the same sensory, spatial, and semantic qualities of visual perceptions" (Hanley, 1988, p. 91). Other researchers have gone even further by claiming that the cognitive processing of images and the perceptual processing of visual stimuli involve many of the same component processes. "These common mental processes in turn produce similar response patterns in imagery and perceptual tasks" (Hanley, 1988, p. 91). Hanley (1988) points out that images can be "substitute" mental representations for perceptions. The implication of this concept of substitutability is that "...people can imagine information and they will then think about and respond to the imagined information as if they had actually perceived it" (Hanley, 1988, p. 92). Richardson (1980) concluded that the research on instructions to image as a learning strategy to encode, store and retrieve verbal information "... has generally demonstrated consistent, reliable and substantial improvements in performance" (p. 71).

Research in instructional technology has turned away from the study of the comparison of specific media. Clark and Salomon (1986) specifically have encouraged instructional technology researchers to focus on teaching strategies, learner attributes and instructional objectives.

Researchers who focus on learner attributes or cognitive styles tend to look for ways to improve instruction for subgroup classifications of a population. One cognitive style which has received a great deal of research attention is field dependence-independence. This cognitive style construct grew out of the "new look" movement of forty years ago which identified several cognitive styles for research and study. Over 2,000 studies have been done using this cognitive style construct (James, 1989).

Different instructional strategies seem to work for the learning of different levels of learning objectives (Dwyer, 1987). Much of the research in the use of instructions to image as an instructional strategy has focused on the use of mnemonics in the recall of word pairs (Bellezza, 1983; Paivio & Desrochers, 1980; Pressley, Levin & Delaney, 1982). This strategy has been found to be particularly successful in remembering foreign language vocabulary (Atkinson, 1975). As effective as these mnemonic imagery strategies have been, there have been few studies which have explored the use of instructions to image as a rehearsal strategy to learn different levels of instructional objectives. The instructional strategy of asking students to image has been successful in a variety of settings including recreating a perceived (real) visual and generating one's own visual image (Hill & Baker, 1983). However, very little is understood about which imagery strategy is most effective for which type of learning objective.

Need for the Study

A plethora of studies have been conducted using field dependence-independence as an attribute treatment (Witkin & Goodenough, 1981). A great deal of research has been done on instructions to image as an instructional strategy. But very little research has been conducted on the combination of both variables. One study conducted on preadolescent students found that instructions to image were superior to supplied visuals as a learning strategy for both field-dependent and field-independent students. Field-independent students exhibited superior recall regardless of the treatment (Carrier, Joseph, Krey & LaCroix, 1983). Joseph (1987) found that field-independent college students scored higher on a series of dependent measures when given imposed visuals rather than when given an imagery task as an instructional strategy. In contrast, field-dependent students scored higher on dependent measures when given the imagery task as an instructional strategy. These results were confounded, however, by the instructional task itself. That is, the content of the lesson was presented via visual text on a computer screen. The imposed visual was presented via an adjunct "handout." The task was to read the text of the lesson from the computer screen and either image or look at the "handout." The confounding factor is described in the research done by Brooks (1967) and Levin & Divine-Hawkins (1974). Brooks (1967) found that mental imagery in adults was more readily elicited during listening than during reading. Similarly, Levin & Divine-Hawkins (1974) found that imagery instructions were more facilitative when children listened to a passage rather than read it. These researchers speculated that the act of reading tends to interfere with imagery

production because both activities require some visual information processing. Because Joseph's study required the students to read and then image, the results may be confounded by the student's reading ability or by their need to process text rather than images.

One additional factor which needs to be explored in imagery research is the level of instructional objectives. Much of the research on the use of imagery in an instructional setting was done to determine an individual's memory for unrelated words. However, it is important to remember that human beings rarely encounter lists of unrelated words outside the research setting. If this research is to have any relevance to memory skills used in everyday life, the role of mental imagery in retaining connected material, e.g. phrases, sentences and text, must be determined. And, from the instructional design point of view, the most appropriate imagery task must be assigned to the most appropriate objectives. While much of the research on imagery asks for low-level recall of factual information, there are other applications for this instructional strategy. It becomes important to know which imagery strategy is most effective for which level of instructional objective. Will the use of imagery as an instructional tool work equally well on higher level learning tasks?

A more in-depth knowledge of learning styles can enhance the design of instruction. Because the field dependence-independence construct is so closely tied to visual/spatial information processing it seems to be the most relevant cognitive style for the field of instructional technology. A better understanding of how individuals perceive and process information may help to explain why students learn from specific mediated instruction.

The use of a variety of instructional strategies has always proven to be effective for classroom teachers and instructional designers. However, it would be beneficial for these practitioners to know which instructional strategy is most effective for which level of instructional objective. Also, by understanding the differences between the effectiveness of visuals versus student-generated images practitioners could make informed choices about effective instructional strategies.

The Effects of Using Mental Imagery as a Teaching/Learning Strategy

One of the constant challenges associated with the teaching-learning process is to determine how learners encode, store and retrieve information. A number of information acquisition models have been proposed which attempt to explain how learners acquire and retrieve information. Tversky (1969) found that verbal and visual information are encoded differently depending on how the learner feels he will use the information. Glanzer and Clark (1963) advanced the notion of a single information-processing system, the verbal loop hypothesis. They believe that visual information is translated and stored as verbal/symbolic information. When this information needs to be retrieved, it is translated from the stored verbal/symbolic form into the visualization form. Paivio, Rogers and Smythe (1968) have developed a theory of dual coding. This orientation proposes a model involving two independent memory systems. One system is able to process verbal symbols and the other is able to process visual information. Although the dual encoding and retrieval systems are perceived as functioning as separate entities, they also possess the ability to function in unison. Depending on the task, whether visual or verbal, that

particular memory system would be initiated. This study will explore the use of mental imagery in the context of how it may be used by instructional designers or classroom teachers, but it is important to look at the theoretical research which has brought about a great deal of knowledge concerning the structure and processing of visual information and mental images.

Two Theories of Visual Information Processing

Although there are other theories on the way visual information is encoded, stored and retrieved, e.g. depth of processing (Craik & Tulving, 1975)} this study will explore only the dual coding theory and the single coding theory. These two theories seem to blanket the majority of research findings on the processing of visual information. In other words, most research findings can be explained within either the dual coding construct or the verbal loop, single coding construct.

Paivio's (1971, 1986) dual coding theory forms the basis of much of the recent research on this topic. The dual coding theory is based on the coding redundancy hypothesis. This hypothesis is based upon the idea that memory performance increases directly with the number of alternative memory codes available for an item (Paivio, 1971). Pictures may be used to present information and may receive both imaginal and verbal representations in memory. This dual coding would enhance the performance on subsequent tests of recall (Richardson, 1980).

Paivio (1986) speculates that these two encoding, storage, and retrieval mechanisms (visual and verbal coding) are independent but often related to one another. He classifies different stimuli in hierarchical order. Paivio

assumes that the greatest possibility of dual coding exists for pictures, then for concrete words and, finally, the lowest possibility for dual coding comes from abstract words. The use of mental imagery as an encoding, storage and retrieval device appears to be more functional when used to remember concrete words. This fact may explain the high number of studies which look at imagery in remembering word pairs (See, e.g. Atkinson, 1975; Levin, 1981; Levin, Pressley, McCormick, Miller, & Shriberg, 1979; Pressley, 1977).

Kosslyn (1980) and Richardson (1980) are the major proponents of the single code theory. Kosslyn (1980) believes that when we see something, some characteristic internal representation must be formed. Some of these representations may be formed as one describes the object or a scene; some may underlie emotional reactions. "Image representations are like those that underlie the actual experience of seeing something, but in the case of mental imagery these representations are retrieved or formed from memory, not from immediate sensory stimulation" (p. 18). Richardson (1980) believes that the processing of verbal information can be explained by the "common coding theory." "Within the common coding theory, the empirical effects attributed to the use of mental imagery can be explained by assuming the greater efficacy of propositional structures which incorporate perceptual or spatial predicates" (Richardson, 1980, p. 145). Propositional theory, simply stated, is the hypothesis that information about sensory modalities may not be available at the time of recall. This idea derives from evidence that when a message is presented to subjects, any sensory aspect of that message is rapidly forgotten but that a more abstract, meaning-related piece of information persists (Anderson, 1985). There is some evidence, however, that students can also

recall the sensory modality in which they received the original information (e.g. Tracy, Roesner, & Kovac, 1988). This would indicate that the sensory mode is also remembered and perhaps propositional theory should be modified.

Richardson (1980) distinguishes between constructive and elaborative uses of mental imagery. Constructive use of mental imagery involves the symbolic representation of pictures and may be spatially transformed. These symbolic representations are maintained in working memory and are short-term and non-verbal. The elaborative use of mental imagery involves symbolic representations which "...may be evoked by the presentation of verbal information to be remembered over an indefinite period of time. In this case, the use of mental imagery may be regarded as a way of elaborating or qualitatively transforming the material to be learned, and it is therefore reasonable to suggest that mental imagery constitutes an elaborative form of coding in long-term memory" (Richardson, 1980, p. 43). Rohwer (1972) describes cognitive elaboration as a strategy which requires the learner to create a symbolic construction that, when combined with the new information, makes this information more meaningful.

This distinction between elaborative and constructive uses of mental imagery becomes important when considering the use of imagery as a learning strategy. Richardson (1980) believes that this constructive use of mental imagery (i.e. non-verbal, short-term, working memory), which may be employed in the representation, preservation and manipulation of spatial and pictorial information, may be disrupted by other concurrent cognitive tasks which require the processing of spatial or pictorial information, and perhaps by any cognitive task which requires the use of the "executive system." In other words, if pictorial

information is presented concurrent with verbal information, interference with either code could occur while the information is in working memory. This constructive use of mental imagery is much different than the elaborative use of mental imagery. Constructive use of mental imagery aids short term memory, and the elaborative use of mental imagery becomes a way of representing visual information in long term memory as symbolic code (Richardson, 1980).

The discussion continues between proponents of both theories. Paivio (1983) continues to support the dual coding theory with few modifications while Kosslyn (1980) and Richardson (1980) continue to support the single coding theory. The dual coding approach to memory distinguished two independent but interconnected symbolic processing systems, a verbal system and a nonverbal or imagery system. The verbal system is viewed as being specialized for dealing with relatively abstract information, such as language, whereas the specialization of the imagery system is processing concrete-perceptual information, such as nonverbal objects or events (Paivio, 1983).

The single-code theory dispels this notion by saying that visual information is processed through propositions, that is, the visual/picture is encoded into a verbal elaboration for storage and later retrieval. The retrieval process may require recoding the original information and therefore produces a similar but not an identical representation (Richardson, 1980). The case of propositions or images as representations in memory has been debated since the 1960's. The proponents of verbal mediation have argued that a single mediating process, which is essentially linguistic in nature, can be used to explain the mental processing necessary for all learning tasks. This traditional approach contrasts with the dual-coding theory on the mediating role of

nonverbal images as well as verbal processes. "Today, propositions are analogous to verbal mediators in their structural and functional properties. The main difference seems to be that propositions are assumed to be more abstract and amodal than the sentences they resemble" (Paivio, 1983, p. 308). The main assumption in dual coding is that cognition consists largely of the activity of two partly interconnected but functionally independent and distinct symbolic systems. "Partial interconnectedness" was always assumed by Paivio. Sometimes this interconnectedness has proven to be incomplete, but that has been caused by the type of stimuli used to create mental images. For example, it is more difficult to image abstract words than concrete words (Paivio, 1983). The argument between dual coding theorists and single code theorists persists. Perhaps Paivio (1983) will have the last word:

Dual coding and imagery based theories generally account for a wide range of findings, which cannot be handled by abstract descriptive approaches except by the addition of *post hoc* assumptions with each new turn in the data. Moreover, the imagery based theories have been productive in generating new observations, whereas proponents of the descriptive approach have mainly reacted to the data and the explanations produced by the imagery researchers. In other words, the vast majority of relevant facts that have fascinated propositional and imagery researchers alike have been generated by the latter (p. 311).

In the area of pictorial learning, Richardson (1980) agrees that the "...dual coding model may therefore be regarded as the most appropriate theoretical approach for the future investigation of pictorial memory" (p. 144). On a practical level, however, Richardson (1980) concluded that the use of mental imagery as

a learning strategy, "...has generally demonstrated consistent, reliable and substantial improvements in performance" (p. 71). Whichever theoretical explanation is appropriate, the fact remains that certain types of mental imagery work effectively on certain types of information processing tasks with a variety of ages and cognitive styles.

In the area of verbal learning the research in the use of mental imagery has focused on three areas: the investigation of "instructions to image" in a learning situation, the comparison of stimulus material in terms of concreteness or imagability, and the comparison of individual subjects in their ability to use mental imagery in learning (Paivio, 1983). The review of literature on instructions to image in a learning situation must focus on both the research in the processing of visual information and the research of mental imagery.

Processing of Visual Information and Its Connection to Instructions to Use Mental Imagery as a Learning Strategy

In a review of literature on the use of pictures to enhance learning from prose passages, Levin and Lesgold (1978) found that pictures facilitated learning when the prose passages were presented orally to children. This effectiveness carried over when the passages were fictional narratives and when the pictures overlapped or were germane to the verbal content. Pictures also enhance learning when learning is measured by factual verbal recall. Showing pictures concurrent with the text also tends to enhance children's memory for more difficult material such as expository text. Pictures helped fifth-grade students on memory tasks of a social studies text more than a read-only control condition or a self-generated imagery condition (DeRose, 1976).

Researchers have consistently found that the use of visual stimuli, when used in combination with verbal information, enhances recall and recognition compared to verbal information only (Fleming & Levie, 1978). Many investigators have demonstrated that the mental processes required to process visual information are similar to the processes required to process mental imagery (Finke, 1980; Hanley, 1988; Kosslyn, 1981; Paivio, 1986; Shepard & Cooper, 1982). These common mental processes in turn produce similar response patterns in imagery and perceptual tasks. Mental images can be substitute mental representations for perceptions (Hanley, 1988). It has been shown in recent studies that the use of mental imagery is as effective as the use of visual stimuli given that the learning task and objectives are identical (Finke, 1980; Hanley, 1988; Joseph, 1987). James (1989) demonstrated that the use of instructions to image were as effective as the use of line drawings with students in fourth, seventh and tenth grades. She also demonstrated that both strategies were equally effective for field-dependent and field-independent students.

The Use of Imagery in Prose and Narrative Learning Tasks

Much of the research in the use of mental imagery has focused on enhancing memory for word pairs, free recall of a list of words and foreign language vocabulary, however, comparatively little research has been done on the use of imagery as it pertains to prose or narrative learning. In prose learning, pictures may not facilitate learning with adults as well as with children. Rasco, Tennyson and Boutwell (1975) found that one group of college students performed better on a dependent measure when they were presented pictorial

information concurrently with material they read. The other treatment was students in the read-only condition. However, a strategy which instructed students to form internal mental imagery appeared to be more effective than the imposed picture strategy. This finding, that supplemental pictures do help adults and adolescent learners to process new concepts from expository text, is consistent through the research. Arnold and Dwyer (1975) found that adjunct pictures of verbal information about the physiology of the heart resulted in better performance by students on a test which measured verbal retention. Dwyer (1987) found that pictures aided performance on a drawing test and on overall performance but not on several verbal learning measures. These results suggest that the use of presented pictures may effect different learning outcomes in different ways. In other words, a picture may be effective for low level recall or recognition tasks while the same picture may not be effective for higher level cognitive tasks such as application.

Concreteness of text has been studied along with the use of mental imagery as a learning strategy. Many words have been given imagery values, that is, how well the word elicits images. These ratings are available for nouns (Paivio, Yuille, & Madigan, 1968), for verbs (Lippman, 1974), and for words frequently used by children (Van der Veur, 1975). Hunter, Moore, & Wildman (1982) in a study using paired associates found that, "... paired associates generated from concrete words resulted in significantly greater recall than did abstract material ..." (p. 180). These results held across the subjects ability to image (high or low imagers as measured by the Bett's Questionnaire Upon Mental Imagery) and across the presentation mode (verbal only and verbal/visual) (Hunter, et al., 1982). Paivio (1971) found that word recall was

positively related to the level of word concreteness. A number of studies have used sentences and texts to study the effect of concreteness on recall of information. Begg and Paivio (1969) found that meaning changes were more easily recognized in concrete sentences (a recall type task) while wording changes were easier to detect in abstract sentences (a recognition type task). Richardson (1980) pointed out that the research on phrases, sentences and connected narrative has consistently demonstrated that concrete material is remembered better than abstract material and this is consistent with the studies of the retention of individual words. Anderson (1974) found that sentences which contain concrete adjectives and modifiers were recalled better by adults than sentences redundantly modified. Two criticisms of these research findings on concreteness of text material were that the materials were contrived by the experimenters (the passages were not taken from texts or writings which were considered of practical value) and that the factors of concreteness and comprehensibility were not controlled for. In other words, simply because a student was able to understand the text, that understanding did not necessarily make the narrative "concrete." However, when each of these items were controlled for, the findings indicate that concreteness is a facilitative strategy for meaningful learning of text material (Tirre, Manelis, & Leicht, 1979). This finding seems to support Paivio's (1987) idea that memory is enhanced when text is concrete by nature.

Instructions to image, as described earlier, facilitate paired-associate and word learning, and the effects are similar to those reported in the research on pictures. Interactivity has been shown to be a necessary condition in order for the processing of verbal information to take place. One advantage of mental

imagery, as opposed to experimenter-supplied interactive pictures, is that mental images may be idiosyncratic and, therefore, help in the processing of information into individual memory (Lorayne & Lucas, 1974). Alesandrini (1982) in her review of imagery research says, "Findings indicate that imagery instructions facilitate memory for text passages and other materials" (p. 132). Several studies looked at the use of training in the use of imagery as a student learning strategy. And although it was found to be effective, it cannot be concluded whether the improved learning was due to the training, the imagery instructions, or a combination of both treatments (Alesandrini, 1982).

Although many studies showed that imagery instructions facilitate learning for older children and adults, the effects are not very striking in comparison to the large gains produced by providing a learner with relevant pictures or concrete language. Alesandrini (1982) reported that imagery accounted for a low percentage of the variance in studies by Pressley (1976) and others, compared to learning gains of up to 89% for pictures. But, in general, mental imagery facilitates meaningful learning, "...and this may be especially helpful to learners who are not verbally inclined" (Alesandrini, 1982, p. 133).

One problem with an imagery strategy in which students are asked to use it while reading is that the reading tends to interfere with the imagery production. Two studies found that in both adults and children imagery instructions were more facilitative when subjects listened to a passage rather than read it (Levin & Divine-Hawkins, 1974; Brooks, 1967). Alesandrini (1982) feels that the imagery effects in many studies may have been more effective had the subjects listened to the text rather than been required to read them. An

example of this notion is the Joseph (1987) study. He presented information on the Dwyer Heart Model (1967) via computer text and asked the students to image the text material. He found that field-dependent subjects who used imagery performed better on the dependent measures than field-independent subjects. Perhaps if this study had been conducted via video or audio and adjunct visuals the findings would have been significantly different.

In her review of literature on the use of imagery as a learning strategy, Alesandrini (1982) found that the strategies of pictures, concreteness, and imagery instructions all facilitate learning. She describes the differences in the strategies as varying in degree of effectiveness with mental imagery as the least supportive of instruction. However, recent research has shown that imagery is as effective as pictures (Finke, 1980; Hanley, 1988; James, 1989; Joseph, 1989). The question still remains, under what conditions, with what learners, and in meeting what objectives (recognition, recall, application and so forth) do instructions to image facilitate learning?

Self Generated Imagery

There seems to be a distinction between the effectiveness of self-generated images and experimenter imposed visuals which the subject is required to image. Johnson and Raye (1981) have proposed that the generation of memories from perceived and imagined information differs in automaticity. The process of perceiving an image is typically more automatic than the use of imagination to generate an image. This difference in automaticity produces a difference in the memory of perceptions and imaginations. Because people are unaware of automatic processes, the

memories of perceptions do not contain information about the cognitive processes which took place in order to encode, store and retrieve this information. On the contrary, memories which are derived from imaginations are likely to contain information about the cognitive operations because people are aware of the effort involved in creating that memory. This effortful image generation might reduce a person's ability to simultaneously experience and integrate all the information needed to solve a problem because the effortful process could require most of the person's cognitive resources (Hanley, 1988). On the other hand, this active engagement of the cognitive processes may enhance learning in certain situations with specific individuals. James (1989) found that self-generated mental imagery supplements verbal communications. She found that self-generated imaginal representations were as effective as line drawings for all students (grades four, seven and ten), and she found that self-generated mental imagery was as effective as line drawings for field-dependent as well as field-independent students. James cautions that the application of mental imagery to situations that do not involve concrete verbal communication would not be as effective as concrete experimenter presented visual representations. This recommendation coincides with research presented by Alesandrini (1982), Geisen and Peeck (1984), and Paivio (1971, 1986).

Types of Imagery

Researchers have used imagery in a variety of learning tasks: mental imagery in sports, problem solving in language arts, creative writing in English and history, and creativity in the other arts (Fleming, 1983). Fleming (1983)

points out that the use of the appropriate imagery processes in specific learning conditions with specific outcomes in mind "... remains a considerable obstacle, partly because of insufficient research on some kinds of imagery, and partly because of the diversity of types of imagery and the likelihood that different instigating conditions are required for each" (p. 152).

Hill and Baker (1983) have devised a typology continuum which defines guidelines for six types of imaging tasks and how each can be used for information processing. The authors of this typology suggest a continuum where "... the recall or reconstruction of prior sensory experience might be considered as belonging at one end of the continuum while the kind of imagery which is more closely linked to some internal reality invented by the subject might be placed near the other end" (p. 134). The authors have divided this continuum into "types" of visual mental imagery. It is not necessary to be proficient at one imagery type in order to be able to perform any of the other types of imagery.

Type 1 imagery is "... essentially static." (Hill & Baker, 1983, p. 135) It is the kind of imagery used when one is asked to recall what one's living room looks like. "... it is a memory image, not an imagination image" (Hill & Baker, 1983, p. 135).

Type 2 imagery is the representation of non-visual information in visual form. For example, one forms images when one reads text or listens to an audio passage. This is an image "generated" by the individual. It requires that the learner draw upon previous knowledge and experience. The essence of this imagery skill is to be able to create a mental picture by using already stored

information (Hill & Baker, 1983). Self-generated images have been shown to help students organize information (Yuille & Marschark, 1984).

Type 3 imagery involves the imaginative manipulation of elements in a visual field. Several studies have been done which require the subject to manipulate a picture by mentally unfolding it or turning it so that it makes a different object (Shepherd & Cooper, 1982). Another skill using this type of imagery is the manipulation of a visual image in space (Hill & Baker, 1983).

Type 4 imagery is the use of metaphor to create an image removed from reality which will make the concept or invisible reality (an atom and its electrons, for example) more "real" for the learner. This type of imagery is "externally" generated, that is, it is generated by an outside stimulus, a teacher, for example (Hill & Baker, 1983).

Type 5 imagery is an extension of the fourth. But instead of being given a metaphor or analogy, the students generate their own mental analog to account for the behavior of a system. This type of imagery takes a long time to "ferment" in the mind. Hill and Baker (1983) use as an example of this type of imagery the way in which Einstein developed his theory of relativity. It is said that Einstein visualized the subway in which he was riding as it approached the speed of light (Hill & Baker, 1983).

The authors' Type 6 imagery is "... not really a coherent class but rather an ill-defined end point on the visual imagery continuum. Hallucinations fall into this category. These images are random and disorganized and indicate some kind of disturbance" (Hill & Baker, 1983, p. 138).

Hill and Baker (1983) point out that the levels of imagery on their typology are not hierarchical in mastery levels. You do not have to master Type

1 before you can learn Type 2. The "types" are "somewhat" hierarchical in skill levels, however. For example, it is more difficult to generate one's own imagery metaphor than it is to generate an imagine of a "real" object or picture which one has seen previously.

The two types of imagery which are most often used in educational settings as described by Hill and Baker (1983) are Type 1 and Type 2. An example of Type 1 imagery is: The teacher presents the picture of a honey bee. The student looks at the picture and then it is removed. The teacher then asks the student to image the picture and store it in his memory. That is a Type 1 imagery task. Those strategies which ask the student to encode, remember, store or associate an image may help on simple memory tasks. When the teacher asks the student to imagine what the surface of the planet Mars looks like from a description of its surface, that is a Type 2 imagery task. This second type of imagery task is concerned with the drawing together of previous experiences to form a coherent picture. It seems that this Type 2 imagery task requires skills which would take a longer time to develop, and therefore, would be more available in adults than in children (Hill & Baker, 1979). Learning tasks which require the application of previous knowledge are obviously more easily accomplished by the person who has some previous knowledge. This maturity which comes with age and, therefore additional knowledge, can be considered an individual difference. These individual differences are sometimes called attribute variables. Other examples of the individual differences in ability to image might include field dependence-independence, locus of control, or extrovert/introvert as well as gender differences. The following section will

describe some findings which relate to imagery and individual differences in learners.

Imagery and Individual Differences

Research indicates that there are developmental differences in the ability to image (Slee, 1983). The ability to use imagery as a memory aid may differ in people's maturity levels, on their creative ability, and to some degree on their gender (Forisha, 1983). Slee (1983) found that some adults cannot seem to generate voluntary imagery following specific instructions. Imagery seems to be a very individualistic skill. It has recently been found that general verbal ability may also be a factor in the use of imagery as a rehearsal strategy. Pressley, Cariglia-Bull, Deane, and Schneider (1987) have shown that intellectual ability correlates with the ability to image. Joseph (1987) did a study which explored the relationship of imagery to field-dependence cognitive style. He presented information via text on a computer screen. Joseph found that imagery was not effective with field-independent subjects but that the use of an imagery learning strategy enhanced the performance of field-dependent subjects on a group of dependent measures. Carrier, Joseph, Krey and LaCroix (1983) found that the use of imagery for sixth-grade children was superior to supplied visuals for both field-dependent and for field-independent students. Thus, the field-dependence cognitive style seems to be an appropriate attribute variable when studying the use of mental imagery as a learning strategy because of its conceptual ties to visual and spatial learning.

The Field Dependence-Independence Cognitive Style

The constructs of field dependence-independence and psychological differentiation grew out of the work of Witkin and Goodenough which began in 1948. In their earliest studies they were seeking to find out how people locate the upright as quickly and accurately as they ordinarily do. A concurrent finding to these "upright" studies was that people are quite different in the way they perceive their surroundings. Those who are considered field-dependent tend to rely on the surrounding field for perceptual cues while those who are considered field-independent rely on internal cues (Witkin & Goodenough, 1981). Witkin (1981) devised a continuum to identify the extremes of this cognitive style. At one end is the articulated individual or the field-independent person. At the other end is the global perceiver or field-dependent individual.

In the early studies done by Witkin and his associates it was found that people who performed well on a series of three tests were field-independent. Those tests were a Rod and Frame Test (RFT), Body Adjustment Test (BAT), and the Rotating-Room Test (RRT). While participating in the Rod and Frame Test people are placed in a darkened room and shown a lighted frame which could be rotated and a rod which could be tilted independently of the frame. The subject had to adjust the rod to a position which he perceived as upright. The Body Adjustment Test requires the subject to sit in a chair in a small room. Both the chair and the room could be tilted independently to a variety of positions. The task for the subject was to adjust the chair to an upright position while the room was tilted in a variety of ways. In the Rotating-Room Test the person was seated in a chair which sat in a small room and which rotated in a circular pattern on a track. This created a centrifugal pull on the subject. The

task for the participant was to bring his chair to an upright position as in the BAT. Persons in each of these tests proved to be self consistent throughout each test, that is, any type of adjustment problem was consistent throughout the three tests. For example, if the participant had problems adjusting the rod to upright within the frame, he likely had problems adjusting a chair to the upright as well. The researchers found that the determining factor for each subject's varying degree of success was one's degree of reliance upon the external field of perception or one's degree of reliance upon one's body position, i.e. postural cues. Thus, the term field-dependent was coined to describe a person who relies on the visual field in perception of the upright (Witkin & Goodenough, 1981).

The use of field independence as the concept of overcoming embedded figures in perception came about later. Much of the early research involved the disembedding of a simple figure from a "... complex design that is so patterned that each component of the simple figure is made part of a clear-cut subwhole of the pattern; the simple figure is thereby effectively hidden" (Witkin & Goodenough, 1981, p. 15). In order to locate the simple figure it is important to "break up" the complex figure. It was found that subjects who could not identify the simple figure from the complex figure were also those subjects who could not determine the upright in any of the three previous tests. Field dependence-independence was thus conceived as a perceptual-analytical construct. This perceptual analytical ability manifests itself throughout all of an individual's perceptual skills (Witkin & Goodenough, 1981). Persons found to be field-dependent in their perception of the upright were found to have a more difficult time solving certain problems where the task was to take the critical element out

of an existing context and restructure the problem material so that the element was now used in a different context (Glucksberg, 1956, cited in Witkin & Goodenough, 1981). Another dimension of this research was a relationship between disembedding and structuring. This structuring research came out of the notion that field-independent people tend to deal with the "perceived field" in a more active manner while field-dependent people tend to deal with it in a passive manner. It was expected and found that field-independent people would impose structure on a field which lacks clear inherent organization. A field-dependent person cannot impose structure on a similar perceived field. This ability or inability to analyze and structure perceptual information into a workable framework was identified by Witkin as articulation. Thus, a person who experiences stimuli in an articulated fashion can choose items as discrete from their backgrounds when the field is organized, and can impose structure on a field when the field has little inherent structure. By imposing this structure the person who is articulate in perception views the field as organized. This, then, is the field-independent person. A person who does not have these articulated perceptual abilities is a global perceiver or a field-dependent person (Witkin, 1981).

This disembedding function forms the theoretical basis for the Embedded Figures Test and the Group Embedded Figures Test (Witkin, Oltman, Raskin, & Karp, 1971). This test classifies people on their ability to locate simple geometric figures embedded within a more complex figure. An individual who tends to be more field-independent is one who is able to perceive the upright, separate parts from the whole, and impose structure on unstructured perceptual information. The cognitive restructuring ability of a field-independent person is

derived from his ability to draw upon internal referents. The lack of this ability in a field-dependent person derives from his holistic perceptions of a given field (James, 1989).

Much of the research on the field dependence-independence cognitive style since 1962 has focused on intellectual activities other than perception. It seems that many of these studies have "...linked field independence in perception of the upright to a number of dimensions of cognitive functioning that may be conceived to involve cognitive restructuring ability (Witkin & Goodenough, 1981, p. 23). It seems that in the initial perception induced by most stimuli field-dependent and field-independent people do not differ. But, when required by the circumstances, field-independent people will restructure their initial perceptual experience. The field-dependent person will accept the prevailing organization of the perceptual field and will adhere to its structure as it is given to them. It is speculated that this ability to restructure in field-independent people remains constant across various modes of intellectual functioning. "However, most factor-analytic studies in the literature suggest that restructuring abilities in the verbal and visual-perceptual domains are not related very highly, if at all" (Witkin & Goodenough, 1981, p. 31). While some recent research (Witkin & Goodenough, 1981) has looked at the field dependence-independence cognitive style in terms of the social behavior and its impact on intellectual functioning, [e.g. it appears that greater individual autonomy is associated with competence in cognitive restructuring (field independence), while greater reliance on external referents is associated with a set of interpersonal competencies (field dependence)], the present study will focus on the intellectual characteristics of this cognitive style.

It should be noted that these differences in perception for field-dependent people are not correlated with intelligence (Wise, 1984). Several studies have demonstrated that the concept of field dependence-independence as measured by the Embedded Figures Test (EFT) or Group Embedded Figures Test (GEFT) does not correlate with intelligence as measured by the Verbal Comprehension and the Attention/Concentration factors of both the Wechsler Adult Intelligence Scale and the Wechsler Intelligence Scale for Children. But positive correlations have been reported between GEFT performance and performance on the Analytic factor (block design, object assembly, and picture completion) of the Wechsler. "Thus, it appears that performance on the Embedded Figures Test is not related to intellectual tasks not requiring disembedding" (Wise, 1984, p. 134).

A great deal of research has been done to determine how the construct of field dependence-independence relates to various aspects of cognition and teaching/learning strategies. Because this construct was derived from visual/spatial experiments it is easy to see why many studies have been done to determine the relationship field dependence-independence has to processing visual information. Several researchers, most notably Dwyer (1972, 1978, 1987) and Wise (1984) have explored the interaction between cognitive style and the type of visual presented. Dwyer (1987) has consistently found that simple line drawings are the most effective presentation of new visual information. Wise, likewise, found that simple line drawings were more effective on a test of comprehension and a test of drawing but found no interaction with field dependence-independence as an attribute variable.

In a study by Canelos, Taylor, and Gates (1980) it was found that field-dependent subjects had more difficulty acquiring spatial information than the field-independent subjects. "This may have occurred because the acquisition of spatial information requires the restructuring of the stimulus situation since each part would be recalled in terms of its relation to the set of all possible parts" (p. 30). This study found that field-dependent subjects were at a disadvantage when compared to field-independent subjects as learning tasks which required restructuring of visual information increased in difficulty. Canelos and Taylor (1981) found that providing an information processing strategy to field-dependent subjects (training them in the use of a combination of peg-mnemonic imagery and hierarchical retrieval techniques) improved their performance on list learning and spatial learning.

Joseph (1987) found that field-independent college students performed better on a battery of tests when the experimenter supplied simple line-drawing visuals with computer generated text of the content. It seems that another treatment, that of self-generated imagery, interfered with the cognitive processing of field-independent students thus producing lower scores than in the supplied visuals treatment. However, he reported that field-dependent subjects scored higher when required to engage in the visual imagery rehearsal strategy.

In a study on sixth grade children, Carrier, Joseph, Krey and LaCroix (1983) found that the use of imagery was superior to supplied visuals for field-dependent and for field-independent students. Additionally, their findings indicated superior recall for field-independent subjects compared to field-dependent subjects, but no interactions. The finding that mental imagery is

superior to experimenter supplied visuals is also contrary to recent research by James (1989). She found no significant difference in recall between prepared visuals and instructions to image for four different age groups of students.

It is generally agreed that field-dependent people lack the ability to disembed or reorganize visual information. Joseph (1987) and Carrier, et al., (1983) found that adult and children field-dependent subjects performed better on learning tasks when using instructions to image while James (1989) found no difference between instructions to image and supplied pictures with no aptitude-treatment interaction with field dependence-independence. If neither strategy is more powerful than the other, at least it can be stated that both are effective instructional/learner strategies. What makes the study of field dependence-independence cognitive style so important is its potentially significant contribution to improving an individual's ability to process visual or spatial information. Many leaders in the field of instructional technology research (Clark, 1983; Clark & Solomon, 1986; Dwyer, 1987) have directed their own research and encouraged other researchers to explore the areas of learning theory which include learner aptitudes. Additionally, these leaders call for exploration of the interaction between learner aptitudes, teaching behaviors, and instructional objectives.

There have been a variety of teaching behaviors which have been proven to be effective under various conditions, e.g. orienting and rehearsal strategies, cueing, visuals, advance organizers, adjunct questions, etc. (See Dwyer, 1987). Logic tells us that none of these particular teaching behaviors will work under all conditions, with all learning styles to meet all instructional objectives. If imagery is a powerful instructional strategy, and it seems to be

effective for some learning styles more than others, it would aid the instructional designer or teacher to know which type of learner outcome is effected by this interaction. Recall of factual information is a different task than recognizing a label and matching it with a visual image. Spatial recall, that is, the total reconstruction of a visual image from memory, is a much different cognitive task than applying factual information to a process. The use of any teaching strategy should be designed to meet learner outcomes or objectives. If it is found that one type of teacher strategy is more effective for one kind of learner outcome then that strategy should be used consistently. One strategy may be effective for a wide variety of instructional objectives, yet may not meet the specific needs of the teacher or designer. It is important to find strategies which meet different student objectives. One line of research which parallels the study of levels of learner objectives is the study of teacher questioning strategies. Research has shown that "higher level questions" will help students to process "higher levels of information" (Redfield & Rousseau, 1982). The following section will review the literature on teacher questioning strategies as they parallel different levels of instructional objectives.

Different Levels of Instructional Objectives

A great deal of research has been conducted on teacher questioning strategies as they relate to the encoding, storage and retrieval of information. Bloom's (1956) *Taxonomy of Education Objectives: Handbook I--The Cognitive Domain* became important in this research because "...it provided a framework for the classification in terms of cognitive complexity not just of educational objectives, but also of teacher questions" (Tanner, 1981, p. 3). It has been

demonstrated that most teacher questions, both oral and written, are asked at lower cognitive levels (e.g recognition and recall), as indicated by Bloom's Taxonomy (Sanders, 1966). Trachtenberg (1974) analyzed over 60,000 study and test questions in history textbooks and teachers' manuals and found that well over 90% of the questions given students were at the Knowledge and Comprehension levels. Kunen, Cohen and Solman (1981) did a cross cultural study between American and Australian students in which they oriented the subjects to different levels of Bloom's Taxonomy (Knowledge, Application, Synthesis, Evaluation). They found that the Taxonomy represents a cumulative hierarchy as stated by Bloom. The results indicate that students of both nationalities performed better on higher level tasks when they were oriented at a higher level. They state, "The results ...provide moderately strong support for the assumption that the Taxonomy represents a cumulative hierarchy of categories of cognitive operations" (p. 208).

Glover, Plake, and Zimmer (1982) did a series of three studies which looked at distinctiveness of encoding in which they used an externally developed and validated task hierarchy (Bloom's Taxonomy). Their findings indicate two things applicable to this study. First, items that require more difficult decisions at encoding are recalled at a higher rate than are items requiring less difficult decisions. Second, the differences in performance may be an indication of greater elaboration and may indicate that more distinctive or memorable traces were formed. Interestingly, the researchers found that varying the time of processing did not affect the quality of processing items of varying difficulties. The authors speculate however that higher order objectives might have been recalled at a higher rate because the subjects had to make more comparisons

of the higher order objectives when compared to definitions than was the case with lower order objectives. This parallels Jacoby, Craik and Begg's (1979) position "...that an increase in task difficulty, or the necessity of carrying out more extensive processing within the semantic domain, results in higher levels of retention" (p. 586). The point here is that the higher performance levels on higher level objectives may not be due solely to the types of questions, but may be effected by the number of semantic mental processes required (Jacoby, Craik & Begg, 1979).

Some studies indicate that the use of higher levels of questions does not enhance higher level learning (see, e.g. Winne, 1979). Redfield and Rousseau (1981) did a meta-analysis which refuted Winne's findings. Because of this conflicting research, studies should be done to explore the nature of different orienting tasks to identify which variation of tasks is most effective for learning which level of cognitive functioning.

In order to establish a common ground on which to talk about different types of instructional objectives a common language is needed. Bloom's (1956) *Taxonomy of Educational Objectives* gives us a vocabulary which is easily understood. Others have developed taxonomic structures for learning outcomes or objectives (Ebel, 1965; Gagne & Briggs, 1979; Merrill, 1971; Walbesser, 1970). The purpose of these classification systems is to give educators a common language on which to base their discussion of learning outcomes.

Benjamin Bloom (1956) points out that probably the two largest classes of intellectual abilities and skills which are emphasized in the public schools are those skills which involve his classifications of "Knowledge" and

"Comprehension." When students are given some form of communication they are expected to encode it, store it, and be able to retrieve it upon command. The objectives of the teacher are to impart knowledge and to have students demonstrate "...an understanding of the literal message contained in a communication" (Bloom, 1956, p. 65). Of course, a communication can be represented in many ways in an educational setting. Books, lecture, audio-visual representations, experiments, demonstrations, and musical works are just some of the examples of school setting "communications."

Because the two most commonly used taxonomic categories are Knowledge and Comprehension, it would appear to be of significant practical educational value to find out which of the aforementioned imagery tasks is most effective for which cognitive task. One other slightly higher level of cognitive activity is the application of knowledge. This is the level where teachers ask students to apply knowledge to a process. Dunkin and Biddle (1974) have noted that there is a parallel variation to the original taxonomy and that is in the area of Knowledge. These two researchers claim that not only does the original taxonomy for knowledge arrange itself hierarchically from simple to complex but it also arranges itself from concrete to abstract. The lower levels of Bloom's Knowledge category are more concrete than the higher levels of the Knowledge category. This "concreteness" fits into Paivio's (1986) theory that concrete information is easier to image. In other words, information which is stored as an image, and is lower in the Knowledge category of Bloom's Taxonomy, should be easier to recall than information which requires higher level processing such as "Application" because it is more concrete and therefore easier to retrieve. If this is the case it would be beneficial to instructional

designers and teachers to know which levels of concreteness and abstractness as designated by Bloom's Taxonomy (1956) can be met by the use of imagery as a rehearsal strategy.

Which of the many taxonomies is used is not relevant to the exploration of learning strategies. An apparent universal understanding is that there are higher and lower level cognitive skills. "Evaluation," the highest level in Bloom's Taxonomy, is not universally accepted (see, e.g. Kunen, Cohen, & Solman, 1981). However, Kunen, et al. (1981) found in their study that subjects who are oriented to study material at the higher taxonomic levels produce higher recall than subjects who are oriented at the lower levels. This finding supports the assumption that the taxonomy represents a cumulative hierarchy of categories of cognitive operations. If using higher order orienting tasks enhances higher order learning, then the next step is to find a variety of orienting tasks which are proven effective for various levels of learning objectives. Imagery has been shown to be very effective for lower level recall of facts (Knowledge on Bloom's Taxonomy)(see, e.g. Atkinson, 1975; Levin, 1981; Levin & Pressley, 1980). Higher level imagery strategies may be effective for higher level learning objectives.

Bloom (1956) has pointed out that there is a difference in levels of learning. There is a difference in the way individuals process information. Different activities can have different effects on learning. It is important to find out which type of imagery rehearsal strategy is most effective for which learning style and to discover which level of learning is most affected by which type of imagery rehearsal strategy.

Summary

Research has consistently shown that the use of meaningful, relevant visuals is an effective method of supplementing verbal information. In most cases the use of mental imagery has proven to be facilitative as an instructional/learning strategy as well. Several researchers have shown that the use of instructions to image have proven to be as effective as supplemental visuals (Finke, 1980; Hanley, 1988; James, 1989; Joseph, 1987).

The encoding, storage, and retrieval of visual information can be explained as independent but often related mechanisms used for visual and verbal coding (dual coding theory) (Paivio, 1981). Or it can be explained in terms of the single code theory (Richardson, 1980). This theory is explained by the elaborative use of mental imagery. Imagery is symbolic representations which may be evoked by verbal information or visual information. Cognitive elaboration is a strategy which requires the learner to create a symbolic construction which when combined with the new information makes this information more meaningful. Richardson (1980) believes that a dual coding model may exist for pictorial memory, but that the use of mental imagery as a learning strategy may require elaboration. The debate continues between those advocates of the single code theory and those of the dual code theory.

A great deal of research has been done on the use of mental imagery as a way of remembering word pairs, word lists, and foreign language vocabulary. Comparatively little research has been done on the use of mental imagery as an aid in enhancing the memory of the narrative text or prose. Audio only presentations seem to aid both children and adults in their memory for prose as compared to the tasks of reading and using mental imagery simultaneously.

Additionally, concreteness of text has been studied along with the use of mental imagery as a learning strategy. It appears that text which is concrete in nature tends to be remembered more easily (See Paivio, 1981).

Self-generated images have been effective for a variety of ages (Hanley, 1989; James, 1989; Joseph, 1987), although there has been little research concerning self-generated imagery and its effect on memory of narrative text or prose. Joseph found that the use of self-generated mental imagery facilitated the learning of field-dependent students who were reading text from a computer screen. Johnson and Raye (1981) have proposed that there is a distinction between the way perceived and imagined information are processed. This distinction involves the automaticity of the process. Imaginal processing is more effortful and perceived processing is more automatic. The memories of perceptions do not contain information about the cognitive processes which took place in order to process the information. The effortful process of self-generated mental images could require most of the person's cognitive resources (Hanley, 1989). On the other hand, this active engagement of self-generated mental images may enhance learning in certain situations with specific individuals.

Fleming (1983) pointed out that the use of the appropriate imagery process in specific learning conditions with specific outcomes in mind remains a problem for instructional designers or teachers. This is because of insufficient research on kinds of imagery. Six kinds of mental imagery have been divided into a typology devised by Hill and Baker (1983). The two types of mental imagery which are most common in the school or training setting are Type 1 and Type 2 as defined by Hill and Baker (1983). Type 1 imagery involves the

reconstruction of previous experienced perceptions. Type 2 imagery is the self-generated images one creates when one reads text or listens to an audio passage. It seems appropriate to begin at the beginning in exploring the types of imagery and their interaction with other variables.

The interaction between the use of mental imagery as a rehearsal strategy and individual differences has been demonstrated to be a fruitful but elusive exploration. Joseph (1987) demonstrated that field-dependent college students performed better with a self-generated imagery rehearsal strategy than with experimenter supplied supplemental visuals. Carrier, et al. (1983) found that the use of imagery for sixth graders was superior to supplied visuals for both field-dependent and for field-independent students.

The research on field dependence-independence indicates that there are individual differences in the way people process information. The field-independent learner is active in the processing of information. This type of person analyzes existing organization and restructures information for meaning when necessary. The field-dependent learner is passive. This learner accepts the structure of organization as it exists and tends to perceive information in a holistic manner often missing the most relevant clues. Field-independent learners tend to perform better on tasks which call for disembedding information, organizing and restructuring information (Witkin & Goodenough, 1981).

The "levels of instructional objectives" variable is of interest because several researchers (Canelos, Taylor & Gates, 1987; Dwyer, 1987) have demonstrated that different teaching/learning strategies have differential effects on different instructional objectives. Additionally, the research on teacher

questioning parallels this research and finds, almost universally, that higher level questions aid in the performance on higher level objectives. It seems that self-generated mental imagery requires different cognitive processing than the reproduction of mental images from supplemented visuals; therefore, it is anticipated that the levels of instructional objectives will be effected by the type of imagery strategy.

Psychological differentiation theory and related research generates the hypothesis that the field-independent learner would function at a higher level when using either of the imagery rehearsal strategies of this study than would the field-dependent learner. This is primarily due to the field-independent learner's ability to restructure information. Additionally, it appears from related research that learners will perform better on the Type 1 (reconstructive) mental imagery strategy in this study than in the Type 2 (self-generated) rehearsal strategy. This is primarily due to the redundancy effect of visual, audio and imaginal coding (Paivio, 1981). It is expected that different mental imagery rehearsal strategies will have differential effects on levels of learning objectives. This hypothesis is generated by the research on questioning strategies. Of primary interest is the study by Glover, et al. in which they found that encoding which requires more difficult decisions are recalled at a higher rate than are items which require less difficult decisions. That is, self-generated imagery would require more encoding decision making than would Type 1 imagery strategies. Additionally, Johnson and Raye (1981) speculate that effortful image generation might reduce a person's ability to simultaneously experience and integrate all the information to solve a problem because the process itself may

require most of the person's cognitive resources. This problem is primarily restricted to the Type 2 imagery strategy.

In conclusion, it is obvious from the research of Witkin, et al. (1971) that when instructional tasks require restructuring in order to encode, store, and retrieve information, field-independent students will out-perform field-dependent students. There is conflicting research on the effectiveness of imagery versus imposed visuals as a learning strategy. This issue seems to be bound to individual differences. Levin and Pressley (1983) report conflicting evidence to support both approaches and conclude that for elementary and junior high students, imposed visuals are as effective as induced images, and in some cases better. They point out that there is not yet evidence to generalize about adults. Because field-dependent students are not very effective in the restructuring of visual information, the use of self-generated imagery may be helpful. Lorayne and Lucas (1974) point out that self-generated mental imagery tends to be idiosyncratic and therefore effective as a memory enhancing device. Alesandrini (1982) points out that the use of mental imagery appears to facilitate meaningful learning, especially for learners who do not process verbal information well. Field-dependent individuals have problems processing visual information, therefore, the Type 2 imagery task, in which students are asked to generate their own mental image rather than process an imposed visual, may prove to be effective as a learning tool for field-dependent individuals. On the other hand, field-independent individuals may perform better after using a Type 1 imagery task because it requires visual and verbal processing using at least two and perhaps three codes: audio, visual, and imaginal. Field-dependent people may be overwhelmed by the complexity of the processing task.

Johnson and Raye (1981) speculate that the use of mental imagery may interfere with the processing of verbal information. However, conflicting research by Glover, et al. (1982) indicates that encoding which requires more difficult decisions is recalled at a higher rate than are items which require less difficult decisions. It is expected that different mental imagery strategies will have differential effects on levels of learning objectives. Primarily, it is assumed that self-generated images (Type 2 imagery) are more difficult to produce than reconstructed imagery (Type 1 imagery) (Hill & Baker, 1983). However, because very little research has been done on the use of different types of mental imagery as a rehearsal strategy for the processing of narrative text or prose and on different levels of instructional objectives, the current research could enhance this field. Additionally, the use of imagery as a learning strategy for field-dependent students may prove to be very effective as indicated by the Joseph (1987) study. However, there is very little definitive research on the effects of different types of imagery strategies on cognitive styles or on the processing of different levels of instructional objectives.

Based on the preceding review of literature and theory, a research methodology designed to answer the following questions will be presented in Chapter Two:

Research Questions

1. Is there a difference in the effects of type of imagery rehearsal strategy on retention of information for students with different cognitive styles (field-dependent-independent)?

2. Is there a difference in the effects of type of imagery rehearsal strategy on the learning of different levels of instructional objectives?
3. Is there an interaction between the type of imagery rehearsal strategy, cognitive style, and the learning of different levels of instructional objectives?

Chapter II

METHODOLOGY

Research Hypotheses

There appears to be a need to identify instructional/learning strategies on a variety of learner aptitudes, and a need to identify which of those strategies and aptitudes interact with different levels of learning objectives. As a way of trying to understand these complex relationships, the following hypotheses were tested in an attempt to answer the earlier noted research questions:

- H#1** Students using either imagery rehearsal strategy will perform at a higher level than the control group.
- H#2** Field-independent students will perform at a higher level on all tasks under all conditions.
- H#3** Field-independent students will perform at a higher level when they use a Type 1 imagery strategy.
- H#4** Field-dependent students will perform at higher level when they use a Type 2 imagery strategy.

Research Design

A series of two-way Analysis of Variance (3x3 post test only) procedures were used with main effects of imagery rehearsal strategy (Type 1 or Type 2 as

defined by Hill's and Baker's typology) and cognitive style (dividing the field dependence continuum into three groups -- field-dependent, neutral, and field-independent). The effectiveness of these strategies were measured on a series of dependent measures designed to measure different levels of instructional objectives. These dependent measures were taken from the Experimental Instructional Materials (EIM) Criterion Tests, commonly known as the Dwyer Heart Model (Dwyer, 1967). There was a Control Group which received the information presented and tested on the various criterion tests without any instructions to image as a rehearsal task.

Participants

The participants were university students, members of intact classes. Treatments were randomly assigned to these different intact classes.

Rationale for Group Embedded Figures Test

The Group Embedded Figures Test (GEFT) was modeled after the individual test for relative field-dependence, The Embedded Figures Test (EFT) and correlations between the two are high (Witkin, et al., 1971). The GEFT is presented in booklet form. It consists of seven practice and eighteen scored figures. The figures are shaded and complex; in each complex figure is embedded one of eight simple figures which are to be traced in pencil by the test taker. It is administered in three timed intervals. The time interval for each section is five minutes. One of the timed sessions is for the seven practice items and the other two timed sessions are for the two scored sections. The simple figures are printed on the back cover of the booklet and the student cannot look at both the complex item and the back of the booklet simultaneously, making

the task more difficult. That is, the test taker may look at the simple figure in order to try to figure out the complex figure, but he cannot look at both at the same time. The score is the total number of simple forms correctly traced in the Second and Third Sections combined. Omitted items are scored as incorrect. (Witkin, et al., 1971).

Norms are available for college students who have taken the GEFT. Men performed slightly but significantly better than women ($p < .005$). This finding is consistent with the gender differences found with the EFT. The norms are presented in Table 1 (from Witkin, et al., 1971).

Table 1

**Norms for College Students Who Have Taken the
Group Embedded Figures Test (GEFT)**

Quartiles	Men	Women
1	0-9	0-8
2	10-12	9-11
3	13-15	12-14
4	16-18	15-18
N	155	242
Mean	12.0	10.8
S.D.	4.1	4.2

(Witkin, et al., 1971)

The norms for college students and adults on the EFT range from 45.5 (seconds per item) to 55.6 for males and range from 63.6 to 84.2 (seconds per item) for females. Females take more time to process the information. The standard deviations range from 22.4 to 36.8 in males to 33.6 to 41.0 in females. These norms and standard deviations are taken from five different studies with a total number of subjects of 336 males and 197 females (Witkin, et al., 1971). Since the GEFT is a speed test, an appropriate method of estimating reliability is the

correlation between alternate forms with identical time limits. Correlations between the First Section scores and the Second Section scores were computed producing a reliability estimate of .82 for both males and females (Witkin, et al., 1971). The GEFT, like the EFT, has been evaluated for validity. The relationship between the GEFT and another measure of psychological differentiation, the degree of articulation of the body concept, was found to be valid for males at .71 and for females at .55. "The combined evidence suggests that the GEFT can be a useful substitute for the EFT when individual testing is impractical" (Witkin, et al., 1971, p. 29).

The Group Embedded Figures Test (Witkin, et al., 1971) is scored by the correctness of 18 items on a continuum. The extreme ends of the continuum indicate high (field independence) or low (field dependence) levels of field-dependence. The middle range, indicates a moderate amount of either field-independence or field-dependence. Many researchers have divided the continuum into a bimodal distribution. Joseph (1987) divided the continuum into those students who have a score of 0-10 (field-dependent) and those students who have a score of 11-18 (field-independent). Many other studies have divided the continuum into bimodal distributions (See, e.g., Canelos, et al., 1987; Wise, 1987). James (1989) and Reardon (1987) divided the continuum into three groups leaving a middle range which indicates a neutral level of field-dependence. This approach makes sense because the difference between a score of 10 and a score of 11 is an arbitrary distinction which in reality may not differentiate between a field-dependent person and a field-independent person. However, if the distribution is divided into three levels of field-dependence it is likely that the lower end of the distribution, i.e. scores of 0 to 12, would more

reliably indicate field-dependent people; conversely the higher end of the continuum (15-18) would likely produce, with assurance, scores which indicate that those people are field-independent. The three levels of the distribution will allow for a more realistic distinction between extreme field-independent subjects and extreme field-dependent subjects.

Rationale for the Use of Dwyer's EIM Content and Criterion Tests

All participants were given a battery of tests which are used with the Experimental Instructional Materials (EIM) (Dwyer, 1967). The EIM studies have been developed around an 1800 word text and 37 visuals. The design also included a five part criterion test: Drawing Test, Identification Test, Terminology Test, Comprehension Test, and Total Criterion Test which is a composite score of the four (4) tests combined (Dwyer, 1987). Dwyer (1978) chose these particular tests because of the results of a survey he conducted which sought to find out what kinds of tasks students are typically expected to perform in the classroom. This was achieved by interviewing a number of high school and college teachers to determine the kinds of performances normally expected of their students and the kinds of tests commonly used to measure student performances. "The survey indicated that over a wide variety of disciplines, students were expected to: (a) learn terminology and facts basic to the course content, (b) identify locations and/or positions, (c) construct and/or understand relationships, and (d) engage in problem solving activities" (p. 44). In order to assess student achievement of these types of instructional objectives Dwyer (1967) developed an 1800 word instructional unit on structure and internal processes of the human heart which are involved during the systolic and

diastolic phases of heart function. The content of this unit was chosen specifically because it provided a hierarchy of several types of educational objectives extending from the learning of basic facts to complex problem solving. The success on each subsequent objective was dependent on acquisition of prerequisite information. "For example, if the instruction began by discussing the diastolic and systolic phases of the heart without providing students with the opportunity to learn the different parts of the heart, their locations, and their interrelationships, the ensuing instruction would be too difficult and the students would learn a disproportionately small amount of information compared to the amount of time spent in interaction with the content" (p. 44). After the content was developed, the criterion tests were developed which would measure student achievement of the different educational objectives.

Criterion Tests

When proceeding through the content of the EIM material the student first learned the basic terminology, then the basic structures of the heart and how to position them in their specific locations, and then comprehend their interrelated simultaneous functions during the systolic and diastolic phases of the heart. The EIM Terminology Test is 20 multiple choice questions designed to measure the knowledge of facts, terms and definitions. "The objectives measured by this type of test are appropriate to all content areas which have as a prerequisite to the more complicated types of learning a comprehensive understanding of the basic elements (terminology, facts, and definitions) indigenous to the discipline" (Dwyer, 1978, p. 45). This is low-level, factual recall learning.

The objective of the EIM Identification Test is to evaluate the student's ability to identify parts or positions of an object. It is a multiple choice test which requires the subject to identify the numbered parts on a detailed drawing of the heart. Each part of the heart is presented in the content of the unit. The objective of the Identification Test is to measure the student's ability to use visual cues to discriminate one structure of the heart from another and to associate specific parts of the heart with their proper names (Dwyer, 1978). This test measures the student's ability to recognize pertinent information. Tests similar to this type of identification test could be used in courses which require students to be able to locate and identify smaller parts within larger objects. For example, students in an auto mechanics class should be tested on their ability to identify and locate the parts of a car engine.

The objective of the EIM Drawing Test is to evaluate student ability to construct and/or reproduce items in the appropriate context. The Drawing Test gives the students a list of terms (18 items) corresponding to parts of the heart. The students are required to draw a diagram and put the number of the part in its proper location. "For this test the emphasis is on the correct positioning of the verbal symbols with respect to one another and in respect to their concrete referents" (Dwyer, 1987, p. 228). The Drawing Test measures the learners ability to acquire spatial information about the parts of the heart. The acquisition of spatial information tends to be more difficult than list learning (Dwyer, 1987).

The EIM Comprehension Test also consists of 20 multiple choice questions. Subjects are given the location of parts of the heart at a moment in its functioning and asked to locate the position of other parts to the heart at the same point in time. This test requires a thorough understanding of the

functioning of the heart in its systolic and diastolic phases. This test was designed to measure understanding of the procedures and processes of the heart. Students must be familiar with the terminology used to describe the heart, be able to recollect the location of various parts and how they relate to each other, and be able to simulate mentally the functions and movements of the various parts of the heart as they would occur during both the systolic and diastolic phases (Dwyer, 1987). This test would measure the ability to apply information to a process. According to Bloom's Taxonomy (1956) this test would measure "Application." However, as noted above, a student must possess "Knowledge" and "Comprehension" in order to perform the higher level task of "Application." This particular test would measure the effect of the imagery rehearsal strategy on the learning of a higher level instructional task, namely "Application."

The Total Criterion Test is the composite of the four (4) previous test scores (78 items). This score would indicate an overall understanding of the content presented. The scores on these tests should be a reflection of the effectiveness of the instructions to image rehearsal strategy as it applies to different levels of learner objectives (Dwyer, 1978).

Students received the drawing test first, then the identification and terminology tests and the comprehension test last. Each student was allowed thirty (30) minutes to take the four tests. Scores on the four individual criterion tests were combined into a composite 78-item Total Criterion Test Score. The Kuder-Richardson Formula 20 Reliability coefficient for the five criterion measures was computed. An average reliability coefficient for each criterion test has been computed from a random sampling of studies which use this

material: .83--Terminology Test, .81--Identification Test, .83-- Drawing Test, .77-Comprehension Test, and .92--Total Criterion Test (Dwyer, 1978).

Many studies have been done using the EIM (Dwyer, 1967) and accompanying criterion tests which measure different levels of instructional objectives (Dwyer, 1987). The Joseph (1987) study cited earlier is an example of one of these studies. Because of the need for a valid and reliable measure in the study of imagery as a rehearsal strategy, the EIM would be an ideal instrument to measure the effects of imagery on the learning of different levels of instructional objectives. The content and tests, because of their extensive use, are extremely reliable instruments as demonstrated by the above Kuder-Richardson scores.

Procedure

Participants were given the Group Embedded Figures Test to determine whether they were field-dependent, field-independent or somewhere on the middle of the continuum. They were also given a pre-test devised by Dwyer (1987) to determine if they had any in-depth pre-knowledge of the anatomy and physiology of the human heart. Dwyer devised this test to assure that the results of studies using his materials would not be confounded by students who have a great deal of knowledge about the human heart (Dwyer, personal correspondence, October 15, 1989). He has included an anatomy pretest in his EIM materials. If a student's score indicated great deal of prior knowledge, the results were omitted; no student performed extremely well on the pre-test. The fact that a participant in the study might have had an extensive knowledge of

human anatomy could have confounded the cell means of a particular treatment.

Each intact group was given a treatment. Treatment One was an audio/visual presentation via linear video tape. The tape included the EIM (Dwyer, 1967) text and visuals [The visuals were "simple line drawings" which have been shown in Dwyer's various studies to be the most effective,(see Dwyer,1987)] which were approximately 1800 words and 37. They were also given instructions to image after each visual. The participants were then given five (5) seconds to recreate the visual representation in their "mind's eye."

Treatment Two was given an audio only presentation of the 1800 word text of the EIM and asked to generate their own mental image of what was being presented via audio tape. They were given the same amount of information and the same processing time as Treatment One.

The third treatment was the control treatment in which the students were given the same information via linear video tape as in Treatment One without the instructions to image. They were given equal time to process the information as Treatment One subjects. This need for equal time was based on film research which indicates that time of processing is an essential element in the retention of information presented via film (May & Lumsdaine, 1958).

After each intact group was given their appropriate treatment, the EIM tests which include the Drawing Test, Identification Test, Terminology Test, and Comprehension Test were given as dependent variables. A composite test score was also used as a dependent measure to indicate a total understanding of the presented information.

Data Analysis

This study meets the assumptions underlying the Analysis of Variance, namely that the observations are random and independent samples from the population, measurement of the dependent variable is on at least an interval scale, the populations from which the samples are selected are normally distributed, and the variances of the populations are equal (Howell, 1985). A series of two-way Analysis of Variance procedures on five dependent measures will be used to determine if there are significant main effects or if there are significant interactions between treatments (See Figure 1). If a significant interaction is present then appropriate secondary analysis would be conducted.

Drawing Test

FD			
FN			
FI			
	AUDIO	A/V	CONTROL

Identification Test

FD			
FN			
FI			
	AUDIO	A/V	CONTROL

Terminology Test

FD			
FN			
FI			
	AUDIO	A/V	CONTROL

Comprehension Test

FD			
FN			
FI			
	AUDIO	A/V	CONTROL

Total Criterion Test

FD			
FN			
FI			
	AUDIO	A/V	CONTROL

Figure 1.

**3X3 Factorial Design on
Five Dependent Measures**

Chapter III

RESULTS

The primary purpose of this study was to determine whether students performed at a higher level when they used one particular type of imagery rehearsal strategy, (self-generated or recreated mental imagery), whether a particular cognitive style, (field-dependence or field-independence) affected the use of imagery, and whether there was an interaction between the type of imagery strategy and the cognitive style. The students were drawn from six (6) intact classes at a large Southeastern land-grant university. One hundred thirteen (113) students participated in the study as part of class requirements. Analysis of data included a statistical comparison of the variance of the treatment groups. The hypotheses were tested with data collected from these intact groups which were randomly assigned treatments. A series of 3 X 3 two-way analysis of variance and each of five (5) different dependent measures was used to interpret the data. Analysis of Variance (ANOVA) was used to determine statistical significance (alpha set at .05) of the main effects, type of imagery strategy and field dependence-independence. A secondary analysis -- a Fisher's Least Significant Difference Test (*t*-test) -- was performed to determine which treatment affected the difference in mean scores on the dependent measures. The Fisher Test is a conservative test recommended for its simplicity and because it is "... applicable to most multiple comparison problems" (Howell, 1985, p. 243).

To determine the level of field dependence-independence, the Group Embedded Figures Test (GEFT) was given to each of the 113 students in the study. The distribution of the scores is reported in Appendix A. This distribution

was stratified into three groups: field-dependent, GEFT score ≤ 12 ; field-neutral, GEFT score = 13 and 14; and field-independent, GEFT score = 15 to 18. These GEFT scores represent a predetermined 40%, 20%, 40% distribution. Two of the cells which represent field-neutral students are small in number ($n=4$ and $n=5$), but the purpose of using the field-neutral groups was to set up a buffer between the field-dependent students and the field-independent students. Thus, the cells of interest on the analysis are field-dependent and field-independent as attribute variables. Type of imagery strategies are the treatment variables.

The dependent measure was a series of criterion tests which measured the learning on different levels of instructional objectives. These measures were devised by Dwyer (1967) and include an Identification Test which measures ability to discriminate or associate (a recognition task), a Terminology Test which measures the ability to know specific facts, a Drawing Test which measures the ability to translate spatial information, a Comprehension Test which measures the ability to apply information, and the total score which represents the total of all four criterion tests. Reliability of all dependent measures was estimated to be .86 using the Kuder-Richardson Formula 20.

The following research hypotheses were explored in this study: #1: Students using either imagery rehearsal strategy will perform at a higher level than the control group; #2: Field-independent students will perform at a higher level on all tasks under all conditions; #3: Field-independent students will perform at a higher level when they use a Type 1 imagery strategy; and #4: Field-dependent students will perform at a higher level when they use a Type 2 imagery strategy.

Hypothesis #1: Students using either imagery rehearsal strategy will perform at a higher level than the control group.

For the groups using either type of imagery rehearsal strategy or the control group, there was no significant difference in mean scores for the dependent variable "to translate spatial information" as measured by the Dwyer Drawing Test $F(2,104)=1.02$, $p>.05$. (See Table 2 for Means and Appendix B for the ANOVA table.)

Table 2

Summary Table of Means and Standard Deviations by Main Effects (Drawing Test)

Group	<u>Treatment (Type of Imagery)</u>			Total
	Self-Generated	Recreated	Control	
Field-neutral				
<u>n</u>	13	5	4	22.0
<u>Mean</u>	10	10.8	11.25	10.41
<u>SD</u>	3.44	2.39	6.70	3.81
Field-dependent				
<u>n</u>	17	13	15	45
<u>Mean</u>	10.35	11.31	11.27	10.93
<u>SD</u>	5.35	3.17	4.1	4.32
Field-independent				
<u>n</u>	12	16	18	46
<u>Mean</u>	12.5	14.5	14	13.78
<u>SD</u>	5.42	2.48	3.74	3.89
Totals				
<u>n</u>	42	34	37	113
<u>Mean</u>	10.86	12.74	12.56	11.99
<u>SD</u>	4.86	3.17	4.34	4.29

NOTE: Maximum possible score = 18

For the groups using either type of imagery rehearsal strategy or the control group, there was no significant difference in mean scores for the dependent variable "to know specific facts" as measured by the Dwyer Terminology Test, $F(2,104)=.02, p>.05$. (See Table 3 for Means and Appendix C for ANOVA Table.)

Table 3

Summary Table of Means and Standard Deviations by Main Effects (Terminology Test)

Group	<u>Treatment (Type of Imagery)</u>			Total
	Self-Generated	Recreated	Control	
Field-neutral				
<u>n</u>	13	5	4	22
<u>Mean</u>	10.08	9	9.75	9.78
<u>SD</u>	3.23	3.74	5.19	3.56
Field-dependent				
<u>n</u>	17	13	15	45
<u>Mean</u>	11.12	11.69	11.6	11.44
<u>SD</u>	3.67	4.15	3.33	3.63
Field-independent				
<u>n</u>	12	16	18	46
<u>Mean</u>	13.33	14	13.72	13.72
<u>SD</u>	4.81	2.19	2.16	3.02
Totals				
<u>n</u>	42	34	37	113
<u>Mean</u>	10.429	12.38	12.43	12.04
<u>SD</u>	4.03	3.65	3.27	3.68

NOTE: Maximum possible score = 20

For the groups using either type of imagery rehearsal strategy or the control group, there was no significant difference in mean scores for the dependent

variable "to apply information" as measured by the Dwyer Comprehension Test, $F(2,104)=.53$, $p>.05$. (See Table 4 for Means and Appendix D for ANOVA Table.)

Table 4

Summary Table of Means and Standard Deviations by Main Effects
(Comprehension Test)

Group	<u>Treatment (Type of Imagery)</u>			
	Self-Generated	Recreated	Control	Total
Field-neutral				
<u>n</u>	13	5	4	22
<u>Mean</u>	10.23	11	9.25	10.28
<u>SD</u>	2.09	3.16	3.86	2.62
Field-dependent				
<u>n</u>	17	13	15	45
<u>Mean</u>	8.65	9.08	9.27	8.98
<u>SD</u>	3.33	2.78	3.56	3.20
Field-independent				
<u>n</u>	12	16	18	46
<u>Mean</u>	13	10.69	10.94	11.39
	2.86	2.92	3.23	3.12
Totals				
<u>n</u>	42	34	37	113
<u>Mean</u>	10.38	10.12	10.08	10.2
<u>SD</u>	3.33	2.93	3.44	3.22

NOTE: Maximum possible score = 2

However, for the dependent measure of "to discriminate" or "to associate" (the recognition task) as measured by the Dwyer Identification Test there was a significant difference in mean scores, $F(2,104)=16.441$, $p<.05$, between the treatments (type of imagery strategy). (See Table 5 for Means and Appendix E for ANOVA Table.)

Table 5**Summary Table of Means and Standard Deviations by Main Effects (Identification Test)**

Group	<u>Treatment (Type of Imagery)</u>			
	Self-Generated	Recreated	Control	Total
Field-neutral				
<u>n</u>	13	5	4	22
<u>Mean</u>	10.08	15.4	13.75	11.96
<u>SD</u>	3.97	2.88	5.56	4.54
Field-dependent				
<u>n</u>	17	13	15	45
<u>Mean</u>	10.53	14.54	14.13	12.89
<u>SD</u>	4.24	4.20	2.64	4.13
Field-independent				
<u>n</u>	12	16	18	46
<u>Mean</u>	11.5	16.13	16.11	14.91
	4.38	2.94	2.52	3.76
Totals				
<u>n</u>	42	34	37	113
<u>Mean</u>	10.67	15.41	15.05	13.53
<u>SD</u>	4.14	3.45	3.06	4.21

NOTE: Maximum possible score = 20

Using the Fisher Test, $t=1.649$, $p<.05$, it was determined that the significant difference in mean scores occurred between the self-generated imagery ($\bar{x}=10.67$) and recreated imagery ($\bar{x}=15.41$) groups. It was also determined that a significant difference, $t=1.612$, $p<.05$, occurred between the self-generated imagery group ($\bar{x}=10.67$) and the control group ($\bar{x}=15.05$).

For the groups using either type of imagery rehearsal strategy or the control group, there was no significant difference in mean scores for the

dependent variable Total Criterion Test, the total score of all four measures, $F(2,104)=2.22$, $p>.05$. (See Table 6 for Means and Appendix F for ANOVA Table.)

Table 6

Summary Table of Means and Standard Deviations by Main Effects
(Total Criterion Test)

Group	<u>Treatment (Type of Imagery)</u>			Total
	Self-Generated (Type 2)	Recreated (Type 1)	Control	
Field-neutral				
<u>n</u>	13	5	4	22
<u>Mean</u>	40.39	46.2	44	42.36
<u>SD</u>	9.33	10.35	20.9	11.79
Field-dependent				
<u>n</u>	17	13	15	45
<u>Mean</u>	40.65	46.77	46.27	44.29
<u>SD</u>	13.60	12.32	11.63	12.65
Field-independent				
<u>n</u>	12	16	18	46
<u>Mean</u>	51.67	55.31	54.83	53.78
	15.05	8.02	10.11	10.96
Totals				
<u>n</u>	42	34	37	113
<u>Mean</u>	43.27	50.71	50.20	47.78
<u>SD</u>	13.37	10.81	12.6	12.76

NOTE: Maximum possible score = 78

In all except one of the dependent measures (Identification Test) it was found that type of treatment mean scores were not significantly different. On the Identification Test, however, students using the Type 2 (self-generated)

imagery strategy performed at a lower level than those students in either the control group or the recreated-imagery group.

Hypothesis #2: Field-independent students will perform at a higher level on all tasks under all conditions.

For all but one of the dependent measures (Dwyer criterion tests) it was found that field-independent students tended to be more effective in the learning of information at all levels of objectives. For field-independent students and field-dependent students there was a significant difference in mean scores, $F(2,104) = 5.89$, $p < .05$, for the dependent measure "to translate spatial information" as measured by the Dwyer drawing test. (See Table 2 for Means and Appendix B for the ANOVA table.)

The Fisher Test used as a secondary analysis, $t = 1.69$, $p < .05$, indicated that the significant differences occurred between the field-independent students ($\bar{x} = 13.78$) and field-dependent students ($\bar{x} = 10.93$) and also between the field-neutral and the field-dependent students. However, as mentioned previously, because of the small number of students in each of the field-neutral cells the use of those student scores served only as a buffer. The two groups of interest under the attribute variable, cognitive style, were field-independence and field-dependence.

For field-independent students and field-dependent students there was a significant difference on the mean scores, $F(2,104) = 9.85$, $p < .05$, on the dependent measure "to know specific facts" as measured by the Dwyer Terminology Test. (See Table 3 for Means and Appendix C for ANOVA Table.) The Fisher Test used as a secondary analysis, $t = 1.40$, $p < .05$, indicated that

significant differences in means occurred between the field-independent students ($\bar{x} = 13.78$) and field-dependent students ($\bar{x} = 10.93$).

For the dependent measure "to apply information" as measured by the Dwyer Comprehension Test a significant difference in the mean scores was found between field-independent students and field-dependent students $F(2,104)=7.69$, $p < .05$. (See Table 4 for Means and Appendix D for the ANOVA table.) The Fisher Test used as a secondary analysis, $t = 1.27$, $p < .05$, indicated that the significant differences occurred between the field-independent students ($\bar{x} = 11.39$) and field-dependent students ($\bar{x} = 8.98$).

For the dependent measure "to discriminate" or "to associate" (a recognition task) as measured by the Dwyer Identification Test there was no significant difference in the mean scores for field-independent students and field-dependent students, $F(2,104)=2.25$, $p > .05$ (Appendix E). Field-independent students' mean score ($\bar{x} = 14.91$) on this dependent measure was not significantly different than the field-dependent students' mean score ($\bar{x} = 12.89$).

For field-independent students and for field-dependent students there was a significant difference in mean scores on the Total Criterion Test, i.e. the total score of all four (4) dependent measures, $F(2,104)=7.76$, $p < .05$. (See Table 6 for Means and Appendix F for the ANOVA Table.) The Fisher Test used as a secondary analysis, $t = 4.91$, $p < .05$, indicated that the significant differences occurred between the field-independent students ($\bar{x} = 53.78$) and field-dependent students ($\bar{x} = 44.29$).

The hypothesis that field-independent students would perform better on all of these dependent measures was confirmed except on the recognition task.

Hypothesis #3: Field-independent students will perform at a higher level when they use a Type 1 imagery strategy.

There was no significant interaction between type of imagery rehearsal strategy and cognitive style. As expected field-independent students tended to perform at a higher level on all dependent measures except in the Identification Test. When comparing mean scores on the dependent variable "to translate spatial information" as measured by the Dwyer Drawing Test there was no significant difference, $F(2,104)=1.02$, $p>.05$, between either type of imagery rehearsal strategy for field-independent students or for the control group. (See Table 2 for Means and Appendix B for the ANOVA Table.) The same lack of effect occurred for the dependent variable "to know specific facts" as measured by the Dwyer Terminology Test, $F(2,104)=.02$, $p>.05$ (See Table 3 for Means and Appendix C for the ANOVA Table.), the dependent variable of "to apply information" as measured by the Dwyer Comprehension Test, $F(2,104)=.53$, $p>.05$ (See Table 4 for Means and Appendix D for the ANOVA Table.), and the Total Criterion Test, the total score of all four measures, $F(2,104)=2.22$, $p>.05$, (See Table 6 for Means and Appendix F for the ANOVA Table.).

However, when comparing mean scores on the dependent measure of "to discriminate" or "to associate" (the recognition task) as measured by the Dwyer Identification Test, there was a significant difference, $F(2,104)=16.441$, $p<.05$, between the treatments (type of imagery strategy). (See Table 5 for Means and Appendix E for the ANOVA Table.) By conducting the Fisher Test, $t=1.65$, $p<.05$, for self-generated versus recreated imagery and $t=1.61$, $p<.05$, for self-generated versus the control group, it was determined that the differences occurred between the Type 2 (self-generated) imagery strategy

(\bar{x} =10.67) and both the Type 1 (recreated) imagery strategy (\bar{x} =15.41) and the control group (\bar{x} =15.05).

Hypothesis #3 was not confirmed. The type of imagery strategy had no effect on field-independent students. They had higher scores on all tests no matter what imagery strategy they used. There were no significant differences in mean scores for the control group (Drawing Test, \bar{x} =14.0, Terminology Test, \bar{x} =13.72, Comprehension Test, \bar{x} =10.94, and Total Criterion Test score \bar{x} =50.19) the self-generated imagery group (Drawing Test, \bar{x} =12.5, Terminology Test, \bar{x} =13.72, Comprehension Test, \bar{x} =13.0, and the Total Criterion Test Score, \bar{x} =50.17) or the recreated imagery group (Drawing Test, \bar{x} =14.5, Terminology Test, \bar{x} =14.0, Comprehension Test, \bar{x} =10.69, and Total Criterion Test score, \bar{x} =55.31). However, on the Identification Test there was a significant difference in the mean scores comparing type of imagery strategy (self-generated imagery, \bar{x} =11.5, recreated imagery, \bar{x} = 16.25, and control group, \bar{x} =16.11). These findings indicate that neither type of imagery strategy is more effective for field-independent students.

Hypothesis #4: Field-dependent students will perform at a higher level when they use a Type 2 imagery strategy.

Hypothesis #4 was not confirmed. Field-dependent students did not perform better on any of the dependent measures when using a Type 2 imagery strategy and mean scores were significantly different (lower) on the Identification Test: Drawing Test, $F(4,104)=1.02$, $p<.05$; Terminology Test, $F(4,104)=.02$, $p<.05$; Comprehension Test, $F(4,104)=.53$, $p<.05$; Total Criterion Test, $F(4,104)=2.22$, $p<.05$; Identification Test, $F(4,104)=16.441$, $p<.05$. (See Tables 2,3,4,5,&6 for Means Tables and Appendices B,C,D,E&F for ANOVA

Tables.) By using the Fisher Test it was determined that a significant difference occurred between the self-generated imagery strategy ($\bar{x}=10.67$) and both the recreated imagery strategy ($\bar{x}=15.41$) and the control group ($\bar{x}=15.04$), $t=1.65$, $p<.05$ and $t=1.61$, $p<.05$, respectively. The above stated F scores indicated that there was no interaction between type of imagery and field dependence.

This chapter presented the results of the study examining the effects of two types of imagery rehearsal strategies and cognitive styles on various levels of learning objectives. The results of the analyses indicated the following:

1. At all but one level of instructional objectives there was no effect of type of imagery rehearsal strategy on the learning of either field-dependent or field-independent students. That one exception demonstrated that self-generated imagery was not effective as a learning strategy for a recognition task.
2. At all but one level of instructional objectives field-independent students performed better than field-dependent students.
3. There was no interaction between the type of rehearsal strategy, cognitive style and the learning of different levels of learning objective.

Chapter IV

DISCUSSION

This study was designed to find out if the use of different types of imagery are effective as a rehearsal strategy, to find out if cognitive style plays a role in the use of imagery as a rehearsal strategy, and to find out if one type of imagery strategy is more effective than another for specific learning objectives. Previous research has pointed out the lack of specific criteria for using different types of mental imagery (Fleming, 1983). This study was designed to increase the understanding of imagery as it applies to cognitive styles and different learning objectives.

Discussion

Effects of Type of Imagery

This study demonstrated that on all but one of the dependent measures, the imagery rehearsal strategies were not more effective than the control group. However, on the Identification Test, significant differences in mean scores were found for the type of imagery variable. For the Identification Test only, those students who used a Type 1 (recreated) imagery strategy, that is, those students who were presented with a visual and then asked to use imagery to remember the information, scored higher than the students using the Type 2 (self-generated) imagery strategy. The self-generated imagery strategy asked the students to listen to an audio version of the experimental text and then try to remember the content by creating mental images. Those students in the control group who received no instructions to image also performed better on the Identification Test than the self-generated imagery group. However, there was

no significant difference in the scores of any of the other criterion tests.

Apparently not all types of imagery are effective for all tasks. The results of this study indicated that self-generated imagery was not effective on a recognition type learning task, in fact the mean scores were lower for this strategy.

In general, this study demonstrated that imagery is not more effective than other rehearsal strategies. These results are contrary to the findings of the Joseph (1987) study which found that self-generated imagery was more effective for field-dependent students. In this study self-generated imagery was less effective on the Identification Test for all students no matter what their cognitive style. Hanley (1989) speculates that the effortful process of self-generated mental images could require most of the person's cognitive resources, thus not permitting any additional information to be processed. It must be pointed out, however, that this effect was only evident on the Identification Test and not on any of the other criterion tests.

Another line of Imagery research has focused on the possibility that the reading process itself interferes with a student's ability to effectively use mental imagery. Rasco, Tennyson and Boutwell (1975) found that college students who used imagery while reading performed better than students who were presented with pictorial information while reading. Several researchers in found that the act of reading may interfere with the student's ability to use imagery (Brooks, 1967; Levin & Divine-Hawkins, 1974). These two studies found that students who used imagery while listening to a teacher read performed at a higher level than students who used imagery while reading the same material themselves. Alesandrini (1982), in her review of the literature on imagery also discovered that the imagery effects in many studies may have been more dramatic had the subjects listened to the text rather than been

required to read it. Joseph (1987), on the other hand, asked students to read from the computer screen and found that field-dependent students using self-generated imagery performed at a higher level on a series of tests. Many of these researchers have speculated that the combination of imagery as a rehearsal strategy and the cognitive requirements of the reading process may effect the student's ability to process prose information. However, given this conflicting research, the current study was designed to use audio presentations to control for this possible reading effect. No differences were found in the scores of students who used either type of imagery, except on the Identification Test.

Lorayne and Lucas (1974) believe imagery is idiosyncratic. Because students tend to develop their own unique images when they hear a text passage, they believe that this uniqueness could help students process information into individual memory for further recall. This new imagery information is stored in an existing schema unique to the individual. The uniqueness of the memory will then aid students in the retrieval of information. This advantage was not demonstrated in the current study. The imagery strategies were no more effective than the control group which did not use imagery. But, in the case of the low-level recognition task as measured by the Identification Test, the self-generated imagery strategy proved to be even less effective than the control strategy or the recreated imagery strategy.

Previous studies on the use of imagery have focused on enhancing memory of word pairs, free recall of a list of words and other low-level recall tasks (Levin, 1981; Levin, et al., 1978; Pressley, 1977; Pressley, et al., 1982). The current study attempted to explore the possibility that different types of imagery might help the learning of higher levels of instructional objectives. In

this line of research, difficult decision making (Glover, et al., 1982) had proven to be an important factor. That is, encoding which requires more difficult decisions is recalled at a higher level than is information which require less difficult decisions. It was speculated that the use of imagery, either self-generated or recreated, requires elaborate decisions on how to encode, store and retrieve it. Because of these elaborate decisions, memory would be enhanced, especially at the higher levels of instructional objectives. This did not prove to be the case in this study; there was no significant difference on the tests which measured higher level learning: the Terminology Test, the Drawing Test, or the Comprehension Test. Perhaps the length and difficulty of the text for the Dwyer materials did not allow enough time for the students to make the numerous decisions which were required to process the information. Perhaps the large number of images which had to be created from the 1800 word Dwyer material may have affected the encoding, storing and retrieving of that information. The unexpected result that self-generated imagery on the Identification Test was less effective than the recreated imagery and less effective than the control group, may be explained by the simplicity of the task. The Identification Test requires simply matching labels with a picture. No difficult decisions are required to encode, store or retrieve this type of information. This study did not reinforce the Glover, et al. (1982) theory that difficult decisions aid instruction.

Effects of Cognitive Style

Field-independent students are generally characterized as active participants in restructuring and organizing visual/spatial information while their

field-dependent counterparts are characterized as passive and less able to restructure and organize visual/spatial information (Witkin, et al., 1981). Because of this ability to process visual information it was expected that field-independent students would perform at a higher level on all dependent measures. This expected result was confirmed on four of the five criterion tests thus reinforcing the existing research on the effect of the field-independent cognitive style (Canelos, et al., 1981; James, 1989; Joseph, 1987; Reardon, 1987; Witkin, et al., 1981).

The field-independent students did not score significantly higher than field-dependent students on the Identification Test which measures the ability to discriminate or to associate. This criterion test was designed to measure the lowest level of learning objective in this series of tests, the ability to recognize and match labels with a picture. Both cognitive styles performed at the same level on this one test. Field-dependent students tend to process visual/spatial information in a global manner rather than break it up and restructure it as field-independent students do (Witkin, et al., 1981). It is speculated that in order to perform well on this particular dependent measure it was not necessary for students to restructure the visual information. Field-dependent students appeared to store information in a global manner and still retrieve it effectively enough to answer the questions on the low level Identification Test. On the other hand, field-independent students tend to perform at a higher level on tasks which require visual processing of information, specifically organizing and restructuring of that information for further retention (Canelos, et al., 1981; James, 1989, Joseph, 1987; Reardon, 1987). This ability was demonstrated by the field-independent students' higher scores on the other dependent measures. Field-independent and field-dependent student scores on the

Identification Test were similar which indicated that they were able to perform at the same level on the Identification Test but not on the other tests. This latter outcome was unexpected.

Effects of Interaction Between Cognitive Style and Imagery Rehearsal Strategy

This study failed to identify any interaction between type of imagery strategy and cognitive style on the learning of different levels of instructional objectives. The use of different types of imagery strategies did not improve the learning of either field-dependent students or field-independent students. The hypothesis that self-generated imagery would aid field-dependent students was not confirmed. The hypothesis that recreated imagery would work better for field-independent students also was not confirmed; no particular strategy was superior for the field-independent students. The lack of interaction was inconsistent with the Joseph (1987) study which reported that field-dependent students performed at higher level on the Dwyer (1967) Criterion Tests when they were asked to generate their own mental images. However, no other similar findings have been reported. The major difference in the two studies seems to be that the students were allowed to use as much time as they wanted to sit, read, and draw the images they created. Then they would move on to the next screen. This self-pacing rather than machine-pacing may have contributed to the difference in these two studies.

Recommendations

The previous research findings on imagery as a rehearsal strategy have been consistent in that it is effective as a learning tool (Finke, 1980; James, 1989; Levin, et al., 1983; Paivio, 1971, 1986). However, this study found that

imagery as a rehearsal strategy when used with text was no more effective than the control group. Also, this study found no interaction between type of imagery and cognitive style indicating that one type of imagery is not more effective for one type of cognitive style. The findings that field-independent students generally perform at a higher level on visual learning tasks than do field-dependent students also was consistent with existing research (James, 1989; Reardon, 1987; Witkin, et al., 1981).

Based on the results of this study it is recommended that research which compares the use of imagery to the use of adjunct visuals or compares one type of imagery to another type of imagery should be discontinued. The expected result that field-independent students perform at a higher level in visual tasks has been confirmed many times. The lack of a significant differences between type of imagery rehearsal strategies on the majority of dependent measures and the lack of interaction between cognitive style and type of imagery rehearsal strategy have led to that recommendation. The only reason to pursue this line of research is the hope that other imagery strategies as defined by Hill and Baker (1983) in their typology would be of assistance in the learning of even higher levels of learning objectives, for example, synthesis or evaluation. One of the types of imagery strategies which might be of interest to researchers is what Hill and Baker (1983) describe as metaphor imagery strategy. However, because of the research of Paivio (1986) who points out the need for information to be concrete in order to make imagery more effective as a rehearsal strategy, this avenue of research seems unlikely to be successful.

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Appendix A

Distribution of Group Embedded Figures Test (GEFT)

Appendix A
Group Embedded Figures Test Distribution

Score	Number of Total Subjects	Per Cent	Designation
1	0	0%	FD
2	1	.89%	FD
3	2	1.77%	FD
4	1	.89%	FD
5	4	3.54%	FD
6	1	.89%	FD
7	2	1.77%	FD
8	4	3.54%	FD
9	10	8.85%	FD
10	5	4.43%	FD
11	4	3.54%	FD
12	11	9.74%	FD
13	14	12.39%	FN
14	8	7.08%	FN
15	9	7.97%	FI
16	11	9.74%	FI
17	14	12.39%	FI
18	12	10.62%	FI

Total 113

NOTE: Maximum Score = 18

Appendix B

**ANOVA Table
(Drawing Test)**

Appendix B

Summary ANOVA Table
Comparison of Type of Imagery Treatment and Field Dependence on the
Drawing Test

SOURCE	DF	SS	MS	F	P
Type of Imagery	2	34.741	17.37	1.023	.3632
Field Dependence	2	200.001	100.001	5.889	.0038*
Imagery X Cognitive Style	4	5.392	1.348	.079	.9885
Error	104	1766.135	16.982		

* $p < .05$

Appendix C
ANOVA Table
(Terminology Test)

Appendix C
Summary ANOVA Table
Comparison of Type of Imagery Treatment and Field Dependence on the
Terminology Test

SOURCE	DF	SS	MS	F	P
Type of Imagery	2	.504	.252	.021	.9792
Field Dependence	2	235.931	117.966	9.846	.0001*
Imagery X Cognitive Style	4	8.617	2.154	.18	.9484
Error	104	1246.085	11.982		

* $p < .05$

Appendix D

**ANOVA Table
(Comprehension Test)**

Appendix D

Summary ANOVA Table
Comparison of Type of Imagery Treatment and Field Dependence on the
Comprehension Test

SOURCE	DF	SS	MS	F	P
Type of Imagery	2	9.977	4.988	.53	.5903
Field Dependence	2	144.783	72.392	7.689	.0008*
Imagery X Cognitive Style	4	44.992	11.248	1.195	.3176
Error	104	979.178	9.415		

* $p < .05$

Appendix E
ANOVA Table
(Identification Test)

Appendix E
Summary ANOVA Table
Comparison of Type of Imagery Treatment and Field Dependence on the
Identification Test

SOURCE	DF	SS	MS	F	P
Type of Imagery	2	430.178	215.089	16.441	.0001*
Field Dependence	2	58.974	29.487	2.254	.1101
Imagery X Cognitive Style	4	8.621	2.155	.165	.9558
Error	104	1360.6	13.083		

* $p < .05$

Appendix F

**ANOVA Table
(Total Criterion Test)**

Appendix F

Summary ANOVA Table
Comparison of Type of Imagery Treatment and Field Dependence on the Total Criterion Test

SOURCE	DF	SS	MS	F	P
Type of Imagery	2	625.137	312.569	2.218	.114
Field Dependence	2	2186.959	1093.479	7.759	.0007*
Imagery X Cognitive Style	4	11.882	2.971	.021	.9991
Error	104	14656.604	140.929		

* $p < .05$

Appendix H

**Experimental Instructional Materials (EIM)
(Dwyer Heart Model Text and Line Drawings)**

**Experimental Instructional Materials (EIM) Criterion Tests
(Dwyer Heart Model Tests)**

**Drawing Test
Identification Test
Terminology Test
and
Comprehension Test**

Anatomy and Physiology Pretest

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Vita

Richard A. Couch grew up in Kansas where he attended public schools, Hutchinson Community College on a football and golf scholarship, and graduated from Emporia State University. After graduation, in January of 1970, he moved to Steamboat Springs, Colorado where he was a skier, bartender and did a number of other jobs. Eventually he worked for five years as a professional ski patrolman taking injured skiers off the slopes. During the summers he worked at the internationally renowned National Outdoor Leadership School in Lander, Wyoming where he taught adults the safe and environmentally sound way to use the Wilderness through five week expeditions into the Wind River Mountains of Wyoming.

In 1978 Richard started teaching in a small rural school in northeastern Washington. For five years he taught English, social studies, math, P.E., drama, and special education. In 1983 Richard moved to Plymouth, New Hampshire where he taught Junior High language arts and reading for a year and directed high school and junior high plays. In 1984 he started the MFA theatre program at Virginia Tech. After two years he transferred to the College of Education where he finished his M.Ed. in 1987 and his Ed.D. in 1990. While a graduate student in the Division of Curriculum and Instruction at Virginia Tech he supervised social studies student teachers and was Assistant Director of The Self Instructional Curriculum Lab where he managed the day to day operation for two years. For six months he participated in an internship at AT&T's Client Education in Cincinnati, Ohio. During the school year 1989-1990, he taught two sections of Introduction to Instructional Technology. Richard has presented at national and international conferences and has published several articles.

His research interests include creativity, imagery, critical thinking, and the uses of technology in the public school environment.

Richard is married to Nancy Bondurant-Couch, who is a children's theatre teacher and director. In the fall of 1990 he will join the faculty at Clarion University in Clarion, Pennsylvania, teaching Educational Applications of Microcomputers to preservice teachers and developing other educational computer courses.