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A Study of the Function of Visual Imagery, Type of Mediator, and Associative Frequency in Induced Mediation Paradigms

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A STUDY OF THE FUNCTION OF VISUAL IMAGERY, TYPE OF MEDIATOR, AND ASSOCIATIVE FREQUENCY IN INDUCED MEDIATION PARADIGMS

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INTRODUCTION

Need for the Study

Bugelski and Sharlock (1952) credit McGeoch with saying that although the concept of mediation was an old one, it had generated more discussion than experimentation. Bugelski and Sharlock in commenting on McGeoch's statements had this to say, "The concept of mediation is of great potential value for the psychological analysis of learning, thinking, and insight." (Bugelski and Sharlock, 1952, p. 334) The views of Bugelski and Sharlock represent the current thinking in verbal learning circles relevant to the importance of mediation in symbolic forms of behavior.

The experimental emphasis, at the present time, is upon the conditions underlying the process. With regard to the nature of mediation Jenkins has stated,

> The second task, I believe, is to press on in our experimental attack on the conditions of mediation: that is, we should attempt to discover how these implicit processes are acquired, how they are actuated, how they are inhibited, and in general, how they are employed by the subjects. (Jenkins, 1963, p. 212)

One method by which the conditions of mediation may be discovered is to determine the relationship between this process and many other forms of intervening variables. In commenting on this latter point Mowrer has stated, "But no one, it seems, has addressed himself systematically to the question of the relation between intervening variables and mediators." (Mowrer, 1960, p. 68) These views of Jenkins and Mowrer on the

direction experimentation should take in mediation suggest the need for the current study.

Purpose of the Study

The purpose of this study was to investigate the function of visual imagery, type of mediator and associative frequency in mediate association. The role of these factors was examined within an induced mediation paradigm of the form A-B, B-C, A-C.

Organization of the Study

This paper is organized into six sections. They are as follows:

Introduction. The need for the study, the purpose of the study, the organization of the study, and the mechanics of mediate association.

Review of literature. A review of mediate association, the nature of imagery, and the role of stimulus meaningfulness in verbal learning.

Methods and materials. A description of the methods and materials used in the problem, the statement of the problem, the statement of the hypotheses, the delimitations of the study, and the definition of the terms used.

Results. A presentation of the findings.

Discussion. An interpretation of the findings.

Summary and conclusions. A summary of the study and some concluding remarks or statements.

The Mechanics of Mediate Association

Jenkins in commenting upon the views of the British Associationists on mediate association wrote:

> The classic paradigm of mediate association as set forth by the British associationists is deceptively simple. Briefly, it was held that if an idea, A, was associated with another idea, B, and still another idea, C, was also associated with B, then idea A would come to have some association with idea C. This was called mediate association as opposed to immediate association which arose from direct association through contiguity of the ideas in time or space. (Jenkins, 1963, p. 212)

The process of mediate association provides one method by which the experimenter may demonstrate the existence of mediated behavior. It is inferred by advocates of the mediation theory of learning that whenever the individual attends to some stimulus, internal processes select and guide the response to be made to that stimulus. The internal processes bear some relationship to the stimulus situation, and are based upon the past experiences of the subject. When these internal processes are in the nature of verbal mediating responses, they are what is commonly meant when one talks about thinking. The use of verbal mediating responses by the individual is considered to be an essential part of problem-solving behavior and concept formation.

In the laboratory, mediated behavior can be demonstrated by utilizing paired-associate learning tasks. In three-stage mediation paradigms, one generally refers to the mediator as the B term and the two stimuli to be mediated as the terms A and C. The learning sequence with respect to mediate association in an A-B, B-C, A-C paradigm may be described as follows: The subject first learns a set of A-B associations. He then learns a set of

B-C associations. He is now presented with an A-C test list containing selected pairs of A-C stimuli. It is assumed that some association already exists between each A-C pair because of their association with a common B term on the A-B, B-C training lists. Thus, the A-C associations in the test list should be easier to learn. The kind of model just described is called a three-stage paradigm in mediation parlance. In Table 1 an example of a three-stage paradigm is presented. The arrangement shown is for a single stimulus pair.

Table 1. An example of a three-stage mediate association paradigm showing the arrangement for a single stimulus pair

Paradigm stages	Stimulus		Response
A-B stage	Term A	+	Mediator B
B-C stage	Mediator B	+	Term C
A-C stage[a]	Term A	+	Term C

[a]test stage

The A-C stage of the paradigm is used to test for mediation. One way of doing this is to present the A terms to the subject and see if he can provide the proper C terms. This is the recall method of testing for mediation. A second method is to determine how long it takes for the subject to learn each A-C association as compared with some control. A third way to test for mediation is to use the recognition method. Here, each A item is presented to the subject paired with two or more C items. The subject is required to circle the appropriate C item.

Irregardless of the method used, recall or recognition, the

experimenter must have some method of demonstrating that mediation has taken place between A-C items. This can be done by comparing the rate at which a subject learns A-C items associated with a common mediator as compared with some condition in which irrelevant (two different) B items are interposed between each A-C pair. In Figure 1 an illustration of the mediated and non-mediated conditions for a single stimulus pair in each stage of the paradigm is shown.

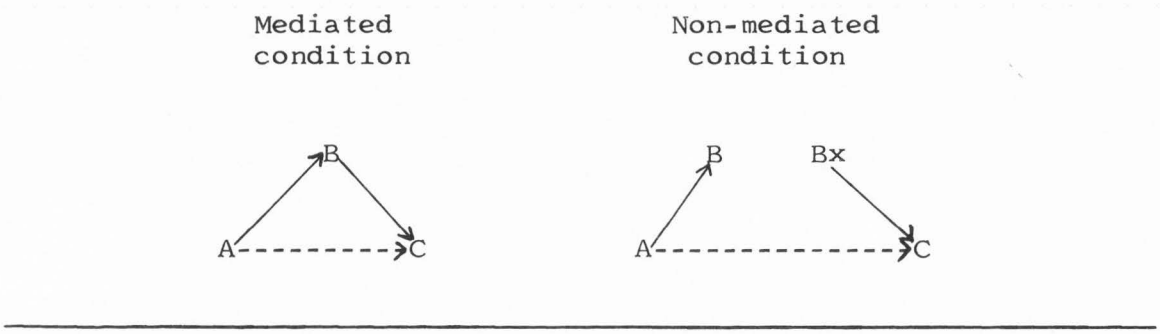


Figure 1. A comparison of the mediated and the non-mediated conditions in an A-B, B-C, A-C chaining paradigm

The learning sequence in Figure 1 follows this formula: Present list A-B to the subject; next present list B-C; then test for mediation with list A-C. Reference to Figure 1 will show that in the mediated condition, items A and C are associated with the same B item. This does not hold true in the non-mediated condition. Here, two different B items are interposed between the A-C terms, therefore, it is assumed that mediation will not take place.

The mediated and non-mediated conditions may be arranged

within a single paradigm and presented to one subject (a mixed design), or an arrangement can be made by which one subject learns mediated A-C pairs, while the other subject learns non-mediated A-C pairs. The latter design was the one followed in the present study. In Table 2 an example of a design of this type is presented.

Table 2. Two A-B, B-C, A-C chaining paradigms showing the arrangement of the stimulus pairs for the mediated and the non-mediated conditions

Paradigm stages					
A-B list		B-C list		A-C list	
Mediated condition					
Tov	Dog	Dog	Mef	Tov	Mef
Dax	Pig	Pig	Nux	Dax	Nux
Vaf	Hen	Hen	Jex	Vaf	Jex
Non-mediated condition					
Tov	Dog	Cow	Mef	Tov	Mef
Dax	Pig	Cat	Nux	Dax	Nux
Vaf	Hen	Ant	Jex	Vaf	Jex

The subjects assigned to the mediated condition learn the A-B list first, then learn the B-C list. They are then presented with the A items and asked to supply the appropriate C items, either by the method of recall or by the method of recognition. Mediation is assumed to occur here because of the common B terms used in the first two lists. The learning sequence is the same for those subjects assigned to the non-mediated condition except that no mediation is assumed to occur because two different B items intervene between each A-C pair.

The order in which the A-B-C events become associated with each other determines the nomenclature of the paradigm. With chaining models, the essential feature is that the mediator (B item) is a stimulus in one list and in a response position in the other list. In the chaining model the A and C terms, therefore, are located in both the stimulus and the response positions. When the mediator is in a response position in both lists, the model is referred to as a stimulus-equivalence paradigm. Here, the A item is a stimulus in the first list and the C item is in a stimulus position in the second list, or vice-versa. In this way the two stimuli acquire an equivalence because of their common association with the same response item. With the mediator in the stimulus position in the first two stages, the model is called a response-equivalence paradigm. Both the A and C items are responses in this type of paradigm. Association with the same stimulus thus renders these two response items equivalent. In Table 3 examples of each paradigm type are presented.

Table 3. Typical stimulus equivalence, response equivalence, and chaining paradigms used in mediate association

Stimulus-equivalence paradigms	Chaining paradigms	Response-equivalence paradigms
A-B, C-B, A-C	A-B, B-C, A-C	B-A, B-C, A-C
C-B, A-B, A-C	B-C, A-B, A-C	B-C, B-A, A-C
	C-B, B-A, A-C	
	B-A, C-B, A-C	

REVIEW OF LITERATURE

The Stimulus-Response Approach to Cognition

Introduction

The early behaviorists viewed the concept of cognition as a construct derived by the cognitive psychologist to account for a behavioral sequence he could neither understand nor measure. To the confirmed stimulus-response theorist, cognition and all it represented was to be disregarded as a factor of concern in behavior. Instead, the psychologist should spend his time refining his science to the point where the presentation of a certain stimulus to the organism would lead to a particular predicted behavioral act. Organismic internal variables had to be disregarded since their precise effect upon behavior could not be measured.

In the early decades of the present century, Structuralism was the dominant school of psychology. The methods employed by this school to study a very restricted range of psychological interests were considered unscientific in some circles (Watson, 1914). Cognition and its study by the method of introspection was a trademark of this school. Furthermore, the study of the mind and its contents was the only real psychology to the Structural Psychologist.

The views of the School of Structuralism were severely criticized in many psychological quarters. But none were as vociferous in their criticisms as a small band of American "rebels" whose cause became known as behaviorism. It was the

contention of this school that the proper subject matter of psychology was behavior, and that the only way to study it was objectively. Hebb (1960) has suggested that this "American Revolution" brought psychology to the portals of science.

The new movement gained many adherents, and aspects of the behavioristic view have flourished in American psychology. It was a viewpoint that provided a way to describe simple behavioral acts. But when the attempt was made to apply the same approach to complex behavioral sequences, certain difficulties were encountered. The difficulties could be overcome only by reference to some relatively unobservable factors within the organism. This many behaviorists refused to do, insisting that behavior could be explained in simple S-R terms. But many psychologists, among them Tolman (1932) and Lewin (1936), challenged the adequacy of a pure S-R explanation for molar forms of behavior either in the rat or the human.

The years of debate that followed clearly focussed the efforts of both sides on many learning issues. On some points there was agreement, while on others wide divergence. In due time, as the fund of knowledge relating to certain learning issues increased, the differences tended to lessen. The cognitive theorist became more receptive to the role of the stimulus in behavior, while the stimulus-response theorist adjusted his position to provide a place for the O variable in the learning process. An example of an adjustment of this nature is the adoption by Spence (1960) of an "L" factor to account for learning not explicable in S-R terms alone.

In the area of cognition, the most notable advance in S-R theory has been the postulation of a mediation hypothesis to account for a response not explicable in terms of a simple stimulus-response formula. While a great deal of research has been done in psychology on the process of mediation, little has been done on the relation of mediation to other organismic variables (Mowrer, 1960). In one of the few studies reported in the literature (Horton, 1964), the experimenter segregated his subjects into fast and slow learning groups, varied the meaningfulness or association value of his learning materials, and recorded the effects of variations in meaningfulness and learning ability upon mediation. Horton's findings were as hypothesized. The amount of mediation obtained was directly related to the meaningfulness of the learning materials and the abilities of the learners.

The mediation hypothesis

The concept of mediation had its historical roots in the principle of the association of ideas first advocated by the early Greek philosophers. Aristotle, the most famous of these philosophers, formulated three principles to account for the association of ideas (Whittaker, 1965). These principles were: similarity, contrast, and contiguity. Aristotle's three primary laws of association were subsequently adopted by the British school of philosophy. These early British Associationists believed that all knowledge came to a man through his senses, and that one idea or event in the mind was aroused and nurtured by a related idea. Events became connected to each other when directly associated or when mutually associated with some third event.

Sir W. Hamilton was among the first men to refer to the concept of mediation. In 1859, he wrote,

> When we find two ideas A and B appearing in succession with no possibility of their previous direct association, we will usually find that both A and B have formerly been associated with an item C. Thus the connection A-B is the result of two other connections A-C and B-C. (Peters, 1935, p. 20)

Other British philosophers reiterated the views of Hamilton. Here, for example, were the words of Hume as he wrote of the manner in which ideas became connected:

> That we may understand the full context of these relations (similarity, contiguity, and cause and effect) we must consider that two objects (ideas) are connected together in the imagination not only when one is immediately resembling, contiguous to, or the cause of the other, but also when there is interposed betwixt them a third object which bears to both of them any of these relations. (Goss, 1961, p. 286)

The belief that mediational processes were factors in learning was accepted by some early behaviorists. About his views of thought as subvocal speech Watson wrote:

> The hypothesis that all of the so-called higher thoughts go on in terms of faint reinstatements of the original muscular act (including speech here) and that these are integrated into systems which respond in serial order (associative mechanisms) is I believe a tenable one. (Watson, 1913, prologue)

What Watson was saying was that a thought, manifested through the mechanism of subvocal speech, produced stimuli which elicited an overt response in the form of an arousal of some bodily habit.

Language habits were one of the human acquisitions Watson considered to be facilitated by mediational processes. His thoughts on the matter were shared by Weiss (1917) and by Hunter (1924). The essence of agreement among these three

men was that language became such only when the individual developed a system of verbal mediating responses to relate environmental events to overt responses. Perhaps the behaviorist who best expressed the role of the mediator in the symbolic process was Dashiell:

> In thought the only satisfactory description of what goes on in an organism is in terms of responses that are set up and that serve in turn as stimuli. Intra-organic reactions now serve as cues. As a formula it would read, S ----→ implicit R ----→ implicit S ----→ overt R. (Dashiell, 1928, p. 522)

Another behaviorist who studied the role of mediation in molar behavior was Gray (1931), who conceived of concept formation as a relationship in which different objects or events evoked the same implicit responses and stimuli and these, in turn, elicited the overt response. Much the same kind of thinking was revealed in the writings of Meyer (1911), who believed that a functional paradigm for concept formation had to be accounted for in terms of implicit verbal mediating responses and stimuli. The early behaviorists attempted to explain thought by reference to a stimulus-response framework that took cognizance of the processes of mediation.

Although the principle of mediation was most adequately championed by Watson and other behaviorists, the concept received its greatest impetus from Clark Hull. It was he who developed the concept to its fullest. In a series of papers by Hull (1930, 1931, 1934, 1935, 1939) the nature of mediation was thoroughly discussed.

In his 1930 paper, Hull introduced the concept of the pure stimulus act. This was a stimulus whose prime function was to

produce implicit cues which would in turn elicit the proper overt response. These pure stimulus acts functioned as intervening variables between the initiating stimulus and the terminal response. In his later papers, Hull identified the fractional antedating goal response as a pure stimulus act. Hull defined the antedating goal response as the anticipation by the organism of the final goal in a behavioral sequence. This r_g, as Hull called it, produced stimuli that guided the organism to the final overt response. One of Hull's prime objectives in learning theory was to relate these intervening variables to observable stimuli and responses. This he tried to do in terms of precise mathematical formulae. That these formulae did not provide an adequate framework within which one could predict the response from the observed stimulus in no way detracted from the importance of his writings on mediation.

The primary contribution made by Hull to mediation theory was the interest he aroused in the phenomenon. It was largely through his efforts that other researchers became involved in the study of mediational processes and their importance in learning, especially in those complex molar acts relating to conceptualization.

Pavlov, the Russian scientist, spoke of mediation in terms of a second signal system (Frolo, 1937). The first signal system referred to stimuli from the outside world, while the second signal system represented the words of the individual acting as stimuli for further responses. Each word in the second system became a signal when it acquired concept status. The concept

then represented or stood for a multiplicity of stimuli in the first signal system.

Edward Tolman (1920) saw mediation as attentive adjustments or sets intervening between the initial stimulus and the final overt response. Edwin Guthrie (1935) spoke of "movement-produced" stimuli as mediating responses. To Miller and Dollard (1950) mediation was a process by which two or more stimuli became associated with the same response. When these stimuli had no prior relationship to each other, Miller and Dollard referred to the relationship as one of acquired stimulus equivalence. To Underwood (1951) mediation was synonymous with concept formation. In concept attainment, according to Underwood, the individual was presumed to perceive a relationship between two or more concept instances. Underwood believed the perception of such relationships depended upon the occurrence of a relevant associative response to these instances. Furthermore, the attainment of the concept was facilitated by increasing the strength of the connections between concept instances.

Osgood (1953) used the mediation hypothesis to explain the association between a sign and the object it signifies. He advocated the hypothesis that words came to represent things because they elicited a behavior also evoked by the object. Some "detachable" portion of a person's total reaction to an object thus became conditioned to the sign which represented it. This total reaction then mediated the connection between sign and significate.

The viewpoint of Bugelski (1956) on the process of mediation

adequately expressed the current view on this topic. To Bugelski, mediation was simply a process by which mediators or intervening activities, which were based on the subject's previous experiences, united other past experiences with some present activity.

The concept of mediation presumably accounts for the processes occurring in delayed reaction learning, semantic generalization, and mediate association.

Research on mediated learning

Delayed reaction studies. Stevens (1951) has suggested that two types of animal behavior have demanded some sort of symbolic process for their interpretation: (1) trace conditioning and delayed reaction learning; and (2) prompt solution of problem situations apparently involving implicit trial and error, insight, or inferential reasoning. With humans, of course, much the same kind of symbolic interpretations are needed to explain thinking. C. T. Morgan has expressed the justification for postulating a symbolic process to explain learning of this kind:

> Only when the response of an organism must be determined by conditions not present at the time of adjustment can it be supposed that a symbolic process is operating. . . . A symbolic process is indicated when the signal or cue for adjustment made is not present at the time of response. (Morgan, 1943, p. 543)

In 1913, W. S. Hunter suggested that symbolic processes were operable in delayed reaction learning. In one delayed reaction experiment conducted by Hunter (1913), animals were confronted with three open compartments in one of which food might be found. The animals were first trained to find food in

the one compartment which was lighted. After the training light was turned on and then off, the animals were forcefully prevented from securing the food for some seconds. The animals were then released and allowed to seek out the food compartment. It was found by Hunter that the animal's response could be delayed for long periods of time without interfering with its ability to select the proper food compartment. Even longer periods of delay could be obtained by showing the food to the animals before placing it out of sight in one of the compartments. Hunter believed the animal's ability to discriminate the correct food compartment from the three compartments available, in the absence of any cue or signal at the time of response, indicated the presence of a symbolizing process on the part of the animals. Furthermore, the learning of delayed reaction discrimination was viewed as the mediation of ready made differential responses to the cues involved. Delayed reaction experiments were also conducted by Hunter (1917) on children. In these experiments, the delay of the child's response had no effect on the correctness of the choices to be made in the experiment. This was found to be true only if the child's response was not unduly delayed. Harlow et al. (1932) conducted delayed reaction studies with primates and found that the period of delay could be increased if the food was first showed to the animals before hiding it from view. Findings similar to the Harlow study were reported by Nissen et al. (1938). This experiment was also conducted with primates. That delayed reaction learning also occurs in lower animals was demonstrated in studies by Wolfe (1934) and by Schiller (1948).

Wolfe used white rats as subjects, while Schiller used fish.

Semantic generalization studies. Hilgard and Marquis wrote about semantic generalization in this way:

> Semantic generalization is generalization which occurs on the basis of the meaning of stimuli. A subject conditioned to respond to the word barn for example, may show a tendency to make the response to other words with rural connotation, for example, tractor. But the response does not occur to nonrural words such as paper. In generalization of this sort the suggestion is that the response requires some intervening activity on the part of the subject. On this basis such generalization may be referred to as mediated. (Hilgard and Marquis, 1961, p. 360)

Guthrie and Powers (1950) have described the mechanism of generalization as essentially the arousal of mediating responses which can serve as signals for the final overt response. If a child is bitten by a dog, for example, the sound of a bark may arouse the verbal association dog, and this mediating response, conditioned to a fear reaction in the child, now arouses that overt response. Any stimulus capable of eliciting the mediating response will produce the fear reaction.

One of the early experiments on semantic generalization was carried out by Yum (1931). In this investigation, subjects first learned to give a four-letter word response to nonsense syllable pairs. For example, the subjects were taught to respond with the word wolf to the stimuli reb-qim. In the recall test, the same syllable pairs with one or more letters rearranged were presented as stimuli. Yum found that many subjects gave the originally learned response to many of the rearranged nonsense syllable pairs, but that the frequency of such recall was related to the number of rearranged letters in the stimuli.

Gibson (1939) obtained results similar to Yum's by training his subjects to give a verbal response to vibratory stimuli. Later, in the test stage of his experiment, Gibson presented his subjects with vibratory stimuli spatially separated from the ones used in the training sessions. It was found that these stimuli also elicited the verbal responses with the frequency of the response being a function of the distance the test stimuli were varied from the application point of the training stimuli.

A classical study demonstrating the principles of semantic generalization was the one by Razran (1939). This investigator conditioned three college students to secrete saliva when shown the words style, urn, freeze, and surf. The conditioning was done by flashing these words on a screen a number of times while the subjects were eating. Later, Razran presented them with the four synonyms fashion, vase, chill, and wave; and the four homophones stile, earn, frieze, and serf. It was found that the saliva response had transferred to the synonyms and the homophones. More generalization occurred, however, to the synonyms. The results of the Razran study seemed to confirm the belief then prevalent in psychology that semantic generalization was basically related to the language habits of the person.

The Razran findings were later replicated by Reiss (1946) who also found that age was a factor in the direction generalization would occur with the synonyms and homophones used. With the word "right," for example, he found that generalization was greatest to the homophone "write" for seven to nine year olds. For the 10 to 12 year olds, generalization was best for the

antonym "wrong;" while with 14 to 20 year olds, generalization occurred more frequently to the synonym "correct." The same pattern generally developed with the other stimuli presented to the subjects.

A study by Foley and Cofer (1943) demonstrated that transfer would occur to more than one homophone of a reinforced word and to a synonym of a synonym of the reinforced word. The reinforcement of a stimulus was carried out by the repetitive presentation of that word, many times, to the subject.

That the associations one has for a particular object can be used to reduce the time needed to acquire a response to the word signifying that object was shown by Osgood (1953). In his study Osgood conditioned a response word to a blue light and found that this response later generalized to the word blue. On the basis of this experiment, Osgood advanced the hypothesis that the meaning of a stimulus provided the means by which generalization could occur between two or more stimuli.

Frequency association chaining studies. Jenkins (1963) refers to frequency association chaining, and induced mediation models as mediate association paradigms. The essential difference between the two models is that pre-experimental language associations exist between at least two of the A-B-C terms in association chaining paradigms.

One of the first frequency association chaining studies was the classical one by Russell and Storms (1955). These investigators, using college students as subjects, divided them into two groups. Each group first learned an A-B

paired-associate list of ten stimulus-response items. The A stimuli were nonsense syllables while B terms were words taken from the Russell-Jenkins norms for the Kent-Rosanoff Word Association Test. Both groups next learned a second list. This was an A-D list for the experimental group and an A-X list for the control group. The A items in both lists were the same nonsense syllables that had been learned in the first list. The D items on the second list were related to the first list B terms in that each B and D term was a close associate of some word (a C item) on the Russell-Jenkins list. Thus one could infer that an association chain B-C-D would be formed with the subjects comprising the experimental group. Although the C items were never presented to the experimental subjects, Russell and Storms reasoned that some of the learning associated with the A-B list would be transferred along the B-C-D chain and facilitate the learning of the A-D list. It was assumed by the two investigators that mediation would not occur with the control group since X words bore no apparent relation to B words on the Russell-Jenkins list. Table 4 is an example of the type of words used in each list.

Table 4. An example of the type of words used in the Russell-Storms experiment

A words	B words	C words	D words	X words
Cef	Stem	Flower	Smell	Joy
Dax	Memory	Mind	Matter	Cheese
Yov	Soldier	Army	Navy	Music
Vux	Trouble	Bad	Good	Table
Wub	Wish	Want	Need	House

When the experimental and control groups were compared on second list learning, it was found that the A-D pairs had been learned significantly faster than the A-X pairs. It was concluded by the two investigators that language habits were factors in facilitating the mediational process.

Studies by Mink (1957), Jeffrey (1957), McGehee and Shulz (1961), and Cieutat (1962) have produced additional data relevant to the role of verbal habit hierarchies in mediate association. All four of these studies were somewhat similar to the one by Russell and Storms (1955). The data obtained by each of these investigators confirmed the Russell-Storms findings that language habits can facilitate the learning of an association between two items.

Several frequency association chaining group studies have been reported in the literature. These have produced conflicting results. The three cited here, those by Cieutat (1962), Hakes and Jenkins (1962), and Odom (1965) were replications of the Russell-Storms (1955) study. Briefly, the findings obtained by Cieutat and by Odom were similar to those obtained by Russell and Storms, while the findings of the Hakes-Jenkins study were negative. All three studies used a recognition test for mediation. College students were used as subjects by Hakes and Jenkins and by Cieutat; Odom, on the other hand, used sixth grade students.

Induced mediation studies. Among the earliest investigations were those of Smith (1894), Howe (1894), and Atherton and Washburn (1912). These pioneer studies were oriented toward the determination of the level of consciousness at which

mediation took place. Each of the studies were characterized by inadequate experimental designs, small sample size, and by disagreement as to the subject's awareness of the mediation process.

The first systematized investigation in mediated generalization was by Shipley (1933). This experiment, later replicated by Lumsdaine (1939), dealt with non-verbal materials. In the experiment, a faint light was first paired with a light tap on the subject's cheek. The tap on the cheek always elicited the response of winking on the part of the subject. Next, Shipley paired the cheek tap with a shock to the finger and found that this produced a finger withdrawal reaction. On subsequent tests it was found that the light alone would elicit the finger response. Shipley pointed out that this reaction always occurred even though the light and the shock were never paired. The explanation given by Shipley for this phenomenon was that the eye blink mediated the finger response from one stimulus, the tap on the cheek, to another, the light flash.

Peters (1935) is generally credited with designing the first induced mediation study in which verbal materials were used as stimuli. This investigator conducted a series of nine experiments testing various paradigms for mediation. In each experiment, nonsense syllables were used as stimuli. Mediation was obtained in only two of the nine paradigms. Where mediation was reported, the subject indicated that he was ideationally aware that the process had taken place.

The Peters study was criticized on several counts: First, it was claimed that he had failed to permit the stimuli to become

associated to the degree needed for maximal mediational effects. Second, his use of a recall method as a test for mediation in the A-C stage of the paradigm was considered to be too insensitive to measure any mediation that had taken place. Finally, the 24-hour periods between each list learning was considered to be too lengthy, expecially in view of the fact that mediation was not suitably provided for within the experiments.

The relatively negative findings of the Peters experiments somewhat discouraged research in this area for several years. However, the paucity of experimentation terminated with the study of Bugelski and Sharlock (1952). The Bugelski-Sharlock experiment was an important demonstration of induced mediation because the positive results obtained led to a resurgence of research in this area. In their experiment, Bugelski and Sharlock asked 20 college students to learn an A-B, B-C, A-C paradigm composed entirely of nonsense syllables. Each of the three lists contained 16 pairs of nonsense syllables arranged so that the experimental and control conditions were encountered by every subject in the experiment (a mixed design). In the A-C list, the first eight stimulus pairs had been associated with a common mediator during the first and second list learning (experimental condition); while the A-C stimuli in the lower half of the list had not been paired with a common mediator in the first two lists. Reference to Table 5 shows the arrangement for the experimental and control pairs in each of the three lists for eight of the stimulus pairs used in the experiment. The data obtained by Bugelski and Sharlock showed that it took 5.3 mean trials for

the 20 subjects to learn the experimental A-C pairs as compared with 7.0 mean trials to learn the control A-C pairs. This was significant at the .05 level of confidence.

Table 5. The arrangement of experimental and control stimulus pairs in the Bugelski-Sharlock study

A-B list		B-C list		A-C list	
		Experimental pairs			
Fuj	Mup	Mup	Qeh	Fuj	Qeg
Gud	Sif	Sif	Nal	Gud	Nal
Jek	Fah	Fah	Tik	Jek	Tik
Lud	Tek	Tek	Lix	Lud	Lix
		Control pairs			
Nof	Dal	Gow	Huy	Nof	Huy
Sux	Gow	Dal	Mog	Sux	Mog
Yob	Qur	Lah	Jax	Yob	Jax
Zew	Lah	Qur	Bup	Zew	Qur

The one criticism levelled at the Bugelski-Sharlock study was that the repairing of mediators in the B-C list for the control pairs had produced maximum interference effects with these items, contributing to the faster learning rate observed for experimental pairs.

A study by Kaplan (1959) compared an induced mediation condition with a frequency association chaining condition in the same paradigm. Kaplan tested a large number of college students on a mixed design A-B, C-B, A-C paradigm. The stimulus pairs in each list were arranged in three ways: First, control pairs were included so that the degree of mediation with experimental pairs could be assessed. Second, some experimental pairs were arranged so that mediation could be induced among them. None of these

stimulus pairs had an associative relationship with each other. Finally, pairs of stimuli showing an associative relationship were used in the paradigm. Kaplan found that stimulus pairs having an associative relationship were learned significantly faster than either the control pairs or the other experimental pairs.

Two well-known studies which examined the amount of mediation produced by various paradigms were those of Kjeldergaard and Horton (1961), and Seidel (1962). Both of these investigations compared college students on a number of different stimulus equivalence, response equivalence, and chaining paradigms. The findings of both studies were similar; that is, mediation was obtained with each type of paradigm tested.

Current status of mediate association

The studies reported in the literature on this topic investigated the following issues:

1. Does the phenomenon referred to as mediate association take place?

Most investigators presently active in this field agree that it does. The preponderance of well-designed studies demonstrating mediation far exceed those that do not. The process of mediation is similar to that of transfer of training except that it is a different process than traditional transfer. In mediational transfer it is the stimuli produced by one's own responses that are transferred, while in traditional transfer a second task is made easier because it contains elements already learned in a prior task (assuming positive transfer here). Jenkins, in commenting on mediational transfer in an A-B, C-B, A-C paradigm,

stated:

> In the three-stage model, the first two stages are, as before, rote-learned with some benefit from having a common response which usually is said to produce some positive transfer. Then in the test stage both A and C should tend to have a high probability of eliciting B and B once elicited, provides a reinforced path to get from A to C. A to B by a forward association and B to C via a backward association. (Jenkins, 1963, p. 225)

2. Can mediation be experimentally induced?

Few investigators question this point any longer. The negative attitudes about the possibility of inducing mediation among the stimuli within a paradigm first aroused by the results of the Peters study (1935), have long been dispelled. It is now generally accepted (Jenkins, 1963) that associative relationships between the mediator and the A-C instances are not a prerequisite to the demonstration of mediation.

3. What paradigm produces optimal mediation?

Mediation has been obtained principally with three different kinds of paradigms: stimulus equivalence, response equivalence, and chaining paradigms. The superiority of any one paradigm over another is still open to investigation. However, the A-B, B-C, A-C chaining paradigm appears to be the most frequently used in mediate association studies.

4. Are subjects ideationally aware that the process of mediation has taken place?

This question has not been settled. A number of studies have been reported in the literature supporting each side of the issue. It appears very likely that mediation can occur without the awareness of the subject, but that awareness <u>per se</u>

does not, in any way, eliminate the process from taking place.

5. What is the relationship of the association value or meaningfulness of the learning materials to the amount of mediation produced?

Experiments designed to examine this variable have produced the same results (Peterson and Blattner, 1963; Horton, 1964). The amount of mediation produced is directly related to the association value of the learning materials.

6. What is the role of interference in a mediate association paradigm?

Some experimenters have suggested that the problem of interference can be minimized by the use of controls (Jenkins, 1963; Kjeldergaard and Horton, 1961). The provision for controls may be handled in two ways; that is, by the use of a mixed list, or by the use of experimental and control groups. In either method, a common B term is interposed between some of the A-C stimuli, while irrelevant or different B terms are interposed between the others. With both the mediated and the non-mediated conditions, interference effects are presumed to be operable. However, the facilitation in learning rate observed within the mediated condition is thought to be due to mediation and not to greater interference among non-mediated items.

7. What is the nature of the mediation process?

There are two basic positions on this question. One of these, the associative mediation concept, emphasizes associative frequencies as the most appropriate cause for the effects observed in mediation paradigms (Jenkins, 1963). Briefly, this

theory advocates that connections are mediated between two or more events because of the arousal of related associates of these events. The second view, the semantic mediation concept, is championed by Osgood (1953). This theory states that associations between two events are mediated by a meaning component held in common by these two events.

The Nature of Imagery

Holt (1964) has made an extensive investigation of the various forms of imagery reported in the literature and has classified them into the following categories:

1. Phosphene imagery. Imagery of this type is brought about as a result of an inadequate stimulation of the retina either through the effects of mechanical pressure or an electric current. In phosphene imagery the subject experiences dots or flashes of color before his eyes.

2. Body image. This type of imagery refers to the mental representation one has of his body at any given moment. The images perceived by the person are not simply visual, but are considered to have kinesthetic and somesthetic components as well.

3. Phantom limb. The individual reports sensations from the area of a surgically removed limb. A comment such as, "It feels like my foot is still there," is indicative of this type of imagery. Although psychological factors probably intensify the process, there is a strong biological basis for the imagery.

4. Hypnogogic imagery. Images appear to the subject

suddenly while he is in a drowsy state just before sleep. These are projected by the individual so that they are, supposedly, "out there." They also appear to be real, vivid, and clear to the person. The images are generally visual or auditory, although they may be of another sense modality. When they occur on awakening they are called hypnopompic images.

5. Hallucinations. No external sensory basis can be found for an image of this type. It is very vivid and colorful to the experiencing organism who believes in the objective reality of the image.

6. Pseudohallucinations. This is a projected image of an hallucinatory status. However, the individual is aware of the subjective nature of the image.

7. Dream image. A normal hallucinatory experience that takes place during sleep.

8. Eidetic imagery. Semi-visual imagery of this type is most prevalent among young children, although it has been known to occur with adults. In eidetic imagery, the person is shown an object and then asked to project an image of it upon some surface--a white screen in some cases. The projected image has the vividness, clearness, and color of the original percept.

9. Synesthesia. The perceptions of one sense modality are strongly intermingled with those of another sense modality. In colored hearing, for example, the person experiences visual images of color along with certain sounds that he hears.

10. After-images. These are due to the continual firing

of retinal receptor cells after the stimulation has terminated. After-images persist for a short time only and then disappear.

11. Thought imagery. Thought images are faint inner representations of prior sensations or perceptions. The images are not dependent upon current sensory input. They are present in the consciousness of the subject as a part of an act or thought. The images may be visual, auditory, olfactory, somesthetic, or kinesthetic.

Brief history of thought imagery

The concept of imagery as an aid to thinking was advanced by the British School of Philosophy. Hume (Boring, 1942), in separating impressions from ideas, stated that the latter in its simplest form could be an image of some prior sensation or perception. Much the same thoughts were held by Mill (Boring, 1942), who believed an image to be a copy or a representation of a sensation in one's mind. To Mill, the basic component of an idea was the image that accrued to it. Hartley (Boring, 1942), also emphasized the relationship between sensations and images. Hartley believed that if sensations were repeated often enough, they left certain vestiges or images of themselves. These he spoke of as simple ideas of sensations. Although the British Associationists recognized the importance of imagery, they evinced little concern with systematically investigating the phenomenon.

Boring (1929) in his History of Experimental Psychology, credited the views of Fechner, Charcot, and Galton on imaginal types as being instrumental in focussing the attention of

psychology on the study of imagery. With respect to the investigations of the three men, the work of Galton was the better known and, perhaps, the more important.

Many of the early investigations on thought imagery were performed by experimenters of the school of Structuralism. The position of this school on imagery was most forcefully championed by Titchener (1909) who postulated three elements of the conscious state--images, affections, and sensations. Images and sensations were used by Titchener in his core-context theory to explain how a stimulus became meaningful to the perceiver. The sensation formed the core of the percept while images related to past experiences accrued to the sensation and gave it meaning.

Insofar as imagery types were concerned, Titchener believed that visual and auditory types were common; tactile and kinesthetic types less so. He thought that taste and smell imagery, although prevalent to a certain degree, played a small part in the consciousness of the individual.

An example of the type of research conducted by the Structuralists on imagery was the study by Moore (1915). This experiment was designed to collect data to support Titchener's core-context theory. In the experiment, Moore presented his subjects with a number of lists containing words, pictures, and objects. By the method of introspection, each individual had to determine the sequence of events occurring in his consciousness at the time of the presentation of the lists and, later, when asked to recall the lists. In immediate perception many subjects reported an awareness of meaning followed by some kind

of imagery but in recall, reported getting an image first followed by an awareness of the meaning of the perceived object.

Interest in imagery remained high while Structuralism was in vogue. People concerned themselves with thinking at that time, and it appeared reasonable to believe that images were basic to the thought processes of the person. However, the work of Kŭlpe at Wŭrsburg (Chaplin and Krawiec, 1960), and the writings of Watson (1913) created problems for Structuralism. Kŭlpe found evidence in many of his studies that thought could occur without any imaginal content. Later, the factors of imagery, attention, and conscious thought all came under the scrutiny of Watson who promptly denied their existence. The findings of Kŭlpe and the criticisms of Watson did much to discredit the concept of imagery among many psychologists.

Therefore, with the exception of intensive studies conducted on eidetic imagery between the two World Wars (Kluver; 1928, 1932), psychologists displayed minimal concern about the area of thought imagery prior to the 1950's. At that time the occurrence of certain events seemed to promise a reawakening of interest in this field, including:

1. Increased investigation into the nature of dreams.

2. The discovery of hallucinatory drugs, beginning with lysergic acid di-ethylamide.

3. The discovery that food, sleep, and sensory deprivation could cause hallucinations.

4. The development of cognitive centers to study the processes involved in thinking.

5. The discovery by research workers that imagery could be evoked by the electrical stimulation of certain cortical and subcortical centers of the brain.

The comments of Hebb on this reawakening of interest in imagery were illuminating:

> In the psychological revolution, the second phase is now getting under way. The first banished thought, imagery, volition, attention, and other such seditious notions. The seditions of one period, however, may be the good sense of another. These notions relate to a vital problem in the understanding of man, and it is the task of the second phase to bring them back (Hebb, 1960, p. 736).

The classification of thought imagery types

Galton was among the first to classify individuals into imaginal types (Boring, 1929). His famous "inquiries" at the breakfast table were among the first attempts to study individual differences among people. By the use of the questionary, Galton asked his subjects to describe that morning's breakfast table, and to describe each article mentioned. The data he obtained indicated that people think in terms of different sense modalities. Some people appeared to be visualizers, giving vivid descriptions of the articles seen on the breakfast table that morning. Others excelled in the auditory or olfactory modalities, while yet another group of individuals, believed by Galton to possess tactual imagery, reported many remembrances of the feel of certain breakfast articles. The existence of a verbalizer type was also discovered. These people recalled with accuracy the morning's events, but could get no clear image of the objects recalled.

In a large number of his subjects, Galton found proficiency in more than one sensory modality. These he referred to as mixed types.

A rather classical investigation on imagery types was the one by Fernald (1912). This experimenter presented her subjects with a series of five objective tests to differentiate the auditory and visual types in her sample. Two of the tests used will serve to illustrate the nature of all five. One, a free association test, classified the person as an audile if he gave many responses of an auditory nature (such as, "bang"). If the majority of the responses were related to the visual modality, he was classified as a visile. The second test required individuals to learn a list of words while subjected to auditory and visual distractions. The theory was that list learning would be disrupted by visual distractions for visiles and by auditory distractions for audiles. A subject's scores on the five tests were later compared with his verbal report of the number and clarity of images perceived during testing. The correlation between the two was positive but low.

A classification system somewhat different from Fernald's was proposed by Griffits (1927). A group of subjects was asked to give verbal reports on the kind and intensity of imagery aroused by a series of pictures. On the basis of the reports, Griffits classified his subjects into three types: a visual concrete type, an auditory-motor-verbal type, and a mixed type. Furthermore, he found the intensity of each imagery type to be subject to variance among the individuals having that type.

A more detailed classification study was that conducted by Lowenfeld (1945). Testing 1,128 subjects with a series of tests that included word association tests, design memorization tests, and design recognition tests, Lowenfeld classified his subjects as haptically inclined or as visualizers. The haptically inclined individual showed a high degree of tactile imagery. When expressed in terms of the number of subjects tested, 47 percent were visualizers, 23 percent were haptically inclined, and 30 percent were non-identifiable.

Brower also studied the question of thought imagery types. Working with 152 college students, Brower presented them with a questionnaire containing such items as these:

> Imagine a pan of onions frying on the stove.
> Can you see the onions?
> Can you hear the onions sizzling in the pan?
> Can you smell the odor of the onions?
>
> Imagine you have touched the handle of the pan.
> Can you feel the handle?
> Can you feel it thermally?
> Do you feel the weight of the pan? (Brower, 1947, p. 199)

These questions required yes or no answers. The order of imagery reported was visual, auditory, tactual, tactuo-kinesthetic, thermal, and olfactory. Brower found pure types in each modality, but a number of mixed types as well.

In a study by Roe (1951), 64 research scientists in the fields of biology, psychology, chemistry, physics, and anthropology were asked whether they used visual imagery in thinking. Those not reporting visual imagery were classified as verbalizers. Roe found that many of the biologists, chemists, and physicists were visualizers, while verbalizers appeared frequently among

psychologists and anthropologists.

Imagery and the thought processes

The relationship between intelligence and visual imagery was studied by Carey (1915), Brower (1947), and Drewes (1954). These experimenters divided their subjects into groups of visualizers and non-visualizers and tested them on a group intelligence test. No relationship was found between intelligence and visual imagery in any of these studies. Carey and Drewes used objective tests to identify levels of visual imagery, while Brower asked his subjects to give verbal reports on the amount of imagery evoked by a group of pictures and designs.

The relationship between visual imagery and the three variables of age, sex, and scholastic ability was investigated by Bowers (1932). No relationship was found between visual imagery and any of these factors. In a study by Davis (1932), the score made by a subject on an achievement test was compared with his aptitude for visual imagery. A small, but significant relationship was found between the two variables.

Among the first studies to deal with the relevance of visual imagery to thinking were those of Pear (1927), Aveling (1927), and Bartlett (1927). In each of these studies, the essential point made by the investigator was that visual images served as carriers of meaning in thinking. Somewhat the same views were expressed by Mowrer. In Learning Theory and the Symbolic Processes he wrote:

> An image in common parlance, is some object which an individual "sees" or otherwise "perceives" without the object being objectively present. By a word,

> another image, or some other stimulus, the individual is reminded of the object and reacts as if it were actually present. In other words a part of the total experience produced by the object itself is here being aroused as a learned, conditioned response; and this response we call an image--and the process of its arousal imagination. Thus without further ado, we shall postulate that images are indeed conditioned sensations, and that, as such, they are an important part--the cognitive or representational part of the meaning which words characteristically come to possess. (Mowrer, 1960, p. 166-67)

The role of visual imagery in thinking was also investigated by Kerr and Pear (1931). These investigators studied imagery as it functions in drama appreciation. They found that imagery could serve to increase one's drama appreciation, that abstract thinking and visual imagery were closely related, and that subjects tended to overestimate the intensity of their imagery. This latter finding supported a similar one reported earlier by Betts (1909).

In a more recent study of the relationship of visual imagery to thinking, Barrett (1953-54) gave a series of tests to 180 school boys ranging in age from 14 to 19 years. These tests were presumably measures of the subject's cognitive abilities in the areas of spatial visualization and spatial reasoning. Individuals were asked to rate each test given them on the extent to which it evoked visual imagery. Barrett's findings were as follows:

1. Those individuals rating spatial visualization tests high in imagery obtained higher test scores, in general, than those rating them low in imagery.

2. Those individuals rating spatial reasoning tests high in imagery obtained test scores, in general, somewhat comparable

to those rating them low in imagery.

The conclusion drawn by Barrett was that visual imagery was related to success on some types of spatial tasks but not on others.

The role of visual imagery in the creative process was studied by Kris (1950). This experimenter hypothesized that creative individuals were more likely to admit primary process material to consciousness than the non-creative person. Kris considered primary process thinking to be concrete in the sense that it was rich in images. To test his hypothesis, Kris presented college students with two questionnaires: one designed to measure the individual's visual imagery status, the other to measure his level of creativity. Kris found that those persons scoring low in creativity also tended to score low in visual imagery. The large number of subjects low in imagery scores but high in creativity scores were explained by Kris on the basis that these people were not using their visual imagery abilities.

A more recent study by Schmeidler (1965), obtained findings similar to those of Kris. Individuals were first divided into visualizers and non-visualizers on the basis of a questionnaire similar to that of Galton's. Creativity scores were then obtained with the Barron Independence of Judgement Scale. The findings of the Schmeidler investigation showed a low but positive relationship between creativity and visual imagery. No individuals with high imagery scores had low creativity scores. However, several subjects with high creativity scores did have low imagery scores.

Imagery studies related to learning

One of the first studies reported in the literature on the role of imagery in learning was the one by Bowers (1929). Working with high school students as subjects, this investigator read to them lists of words related to some sense modality. The words used were related to the visual modality (dog), the auditory modality (bang), and the kinesthetic modality (squeeze). As each word was presented, the subject was to rate it on the basis of the imagery evoked by that word. Later, the subjects were asked to recall as many of the words as they could. Bowers found a low but significant positive relationship between the recall of visual and kinesthetic words and their rated imagery. No relationship was found between the recall of an auditory word and its rated imagery.

A second study by Bowers (1932) examined the relationship between visual imagery and the person's memory for details within a group of pictures. The pictures were shown to a group of high school students who were then asked to recall what they had seen in them. Next, each subject was asked to rate the stimulus elements in each picture as to the degree of imagery aroused. A small but positive relationship was found between the imagery rating of a stimulus element and its recall by the subject.

The relationship of visual imagery to problem solving behavior was also studied by Bowers (1935). Subjects were first divided into groups of visualizers and non-visualizers and then given a number of problems to solve. Each problem presumably differed in the extent to which it could evoke images. The data

obtained by Bowers showed that subjects superior in visual imagery did not solve the problems any easier than those low in visual imagery. Furthermore, the imagery evoking properties of a problem had no effect upon the rate with which it was learned.

That training in visual imagery can improve an individual's memory for word forms was demonstrated by Radaker (1959). This investigator tested school children with a group of tests, among them the Memory For Designs Test, to obtain the child's level of visual imagery. Individuals were then divided into experimental and control groups. Next, experimental groups received training in forming visual images of words. Control groups received no such training. Later, both groups were tested on their abilities to recall a series of 40 words that had been shown to them previously. Those receiving imagery training were superior on the number of correct recalls when compared to the control subjects. The conclusion drawn by Radaker was that training in visual imagery led to improved performances in memory for word forms.

The number of investigations using a paired-associate or mediate association paradigm to study the factor of visual imagery have been few indeed. Among the first studies in this area was that of Bugelski (1962), who had college students learn lists of nonsense syllables varied as to their meaningfulness or association value. In these paired-associate learning tasks, high association value syllables were learned significantly faster than low association value syllables. Following the learning trials, students were questioned about

the imagery evoked by the nonsense syllables. It was found that stimulus pairs reported as evoking the most imagery were the ones most easily learned.

In the studies of Paivio (1963, 1965), and Yarmey and Paivio (1965), the number of trials needed for subjects to learn paired-associate lists composed of abstract or concrete nouns were examined. In each list, the concrete or abstract nouns were either in a stimulus or a response position. Nouns were equated for frequency of usage and, in the latter two studies, rated for their capacities to evoke visual images with concrete nouns being rated higher in this respect than the abstract nouns. The findings of the three studies indicated that the amount of imagery suggested by a stimulus pair was a factor in determining how fast the connection would be learned. Stimulus pairs containing concrete nouns were learned significantly faster than those containing abstract nouns. However, this situation held true only when the abstract and concrete nouns were compared on the stimulus side of a paired-associate list. No essential difference was found between the two when compared as response items.

The role of visual imagery in mediate association was studied in an experiment by Paivio and Yarmey (1965). These investigators compared concrete and abstract nouns as mediators in an A-B, C-B, A-C paradigm. Each noun class was rated for visual imagery prior to the learning phase of the study. It was found that concrete nouns received a higher visual imagery rating than did the abstract nouns. When compared as mediators in the study, concrete nouns proved to be only slightly superior

to abstract nouns as mediators. Paivio and Yarmey accounted for the absence of a greater difference between the two types of mediators as possibly due to the fact that they had been compared in a response position in the paradigm.

Current status of imagery

The present status of imagery can best be described by the phrase, "transition state." The time has been reached in some psychological quarters where imagery has once again donned the cloak of respectability. However, some objections to its value as a phenomenon worthy of study are still being made.

The fact that imagery is not everywhere accorded respectability is partly responsible for the lack of research in this area. Most of the experimentation now being conducted in this field is with hallucinatory imagery and visual aftereffects. Very little research has been done with thought imagery in the past few decades. Another factor responsible for the paucity of research in thought imagery is the difficulty of isolating the effects of mixed imagery within the learning task. Thus, the measurement of precise functional relationships existing between a particular type of imagery and the other experimental variables is difficult to accomplish.

A third factor that has limited the amount of research is the inability of the investigator to predict, once he has identified a certain imaginal type, that the individual will use these abilities in the experimental situation. Yet, in spite of the many difficulties facing the prospective experimenter, the area

remains very much alive. The increased attention being paid to cognition recently has done much to once again direct the thoughts of the experimenter toward the study of imagery.

The salient points of view reported in the literature on thought imagery are as follows:

1. Imaginal types are seldom, if ever, pure. High visual types, for example, may have an ability for several other types of thought imagery.

2. Some studies suggest that an individual scoring high in a particular form of imagery does not always use this ability in some learning task (Kris, 1950). Many times the person simply verbalizes in the learning activity.

3. When used by the person in some learning task, visual imagery appears to improve the learning efficiency of the subject (Bowers, 1932; Bugelski, 1962).

4. The work of Radaker (1959) suggests that the ability to form visual images, and success on some learning task are related.

Studies on the Meaningfulness and Levels of Abstractness of the Learning Materials

A study by Gorman (1961) compared the abilities of groups of students to recall words previously encountered in reading a series of paragraphs. Concrete and abstract words comprised the recall list. These words had been previously rated for levels of abstractness by two English teachers working independently of each other. The data obtained by Gorman showed that concrete

words were recalled more frequently by the majority of the subjects than the abstract words.

Studies by Paivio (1963, 1965), Yarmey and Paivio (1965), and Paivio and Yarmey (1965) all showed a slight to moderate superiority of concrete nouns over abstract nouns as learning materials in either a paired-associate or mediate association learning task.

The first systematic investigation of the function of stimulus meaningfulness in verbal learning was by McGeoch (1930) who constructed 10 item serial lists using nonsense syllables taken from different ranges of the Glaze list. Subjects were presented the lists and later asked to recall the nonsense syllables on them. It was found that the amount of recall was directly related to the association value of the syllable.

Mandler and Huttenlocher (1956) varied the association value of stimulus items in a paired-associate learning task and found that the rate at which stimulus pairs were learned was directly related to the association value of the items. These findings were later confirmed in numerous studies, among them, the one by Bugelski (1962).

That stimulus meaningfulness can be a factor in mediate association was demonstrated by Peterson and Blattner (1963) and Horton (1964). In the Peterson-Blattner study, college students were asked to learn a mixed design A-B, B-C, A-C chaining paradigm. The A-C items used in the study were varied in their association values. Peterson and Blattner used a recognition task in the A-C stage of the paradigm to test for

mediation. Each A item was shown to the subject paired with three C items. The subject had to match the appropriate C term with each A term. The data obtained by Peterson and Blattner showed the amount of mediation produced between the A-C stimulus pairs to be directly related to their association value.

METHODS AND MATERIALS

Statement of the Problem

The primary purpose of this study was to investigate the function of visual imagery and associative frequency in induced mediation paradigms employing either concrete or abstract nouns as mediators. The factors of visual imagery, type of mediator, and associative frequency were studied in chaining paradigms of the form A-B, B-C, A-C. Each of these variables was varied systematically within a paradigm and the amount of mediation thus produced was determined. This was done for boys and girls separately so that some measure of the role of sex differences in mediate association could be obtained.

General Design of the Study

Seventh grade students at Logan Junior High School were tested with the Guilford-Zimmerman Visualization Test, and the Memory For Designs Test. The scores for each subject on the tests were combined to give that person's visual imagery score. Two lists, one for males and one for females, were then constructed. The names on each list were arranged from the highest visualization score to the lowest. The lists were then dichotomized at the median to form visualizer and non-visualizer lists. Each visualizer, male and female, was then assigned in the order that their names appeared on a list to one of four treatments. These were: experimental one (E1), control one (C1), experimental

two (E2), and control two (C2). A similar assignment was made of the male and female non-visualizers. Altogether this resulted in the formation of eight groups. The four experimental groups were then compared with the four control groups in a mediate association learning task. Each group received training on two paired-associate lists (the A-B, B-C lists), and were then tested on an A-C list to determine if mediation had occurred. The experimental paradigms differed from the controls in the arrangement of the B terms. With experimental subjects, common B items were used in the first two lists, while with controls irrelevant B terms were arranged across the two lists.

The B terms employed with experimental one and control one groups were concrete nouns. Conversely, abstract nouns were used as B items with the experimental two and the control two groups. However, the same A and C terms were used with all groups. These were selected from Glaze's list of nonsense syllables. A total of 12 A-C pairs were chosen. Six of these were high associative frequency syllables from the 73-87 percent range. The remaining six were low associative frequency syllables from 13-27 percent.

The A-B list was shown first for five trials. The 12 stimulus pairs comprising this list were presented in paired fashion, with each pair shown for a period of four seconds. The B-C list was then presented in a similar manner. At this point, the A-C list was distributed to the subjects. This list was arranged with each of the A terms matched with six C terms. The individual was instructed to circle the C term that had been indirectly associated with the A term on the two training lists. With control

paradigms, of course, the subject could only guess which C item was the appropriate one.

Statement of the Hypotheses

Hypothesis one

Experimental groups will make more correct responses on the A-C mediation test than the control groups.

Hypothesis two

The amount of mediation occurring in experimental paradigms will be a function of the associative frequency of the A-C stimuli.

Hypothesis three

Concrete words will be more effective mediators than abstract words.

Hypothesis four

Visualizers will make more correct responses on the A-C mediation test than the non-visualizers.

Hypothesis five

There will be no significant learning differences between males and females.

Rationale for the Study

It was considered plausible to initiate a study of this type for several reasons: First, the work of Hull (1939) on the nature of mediation indicated that this phenomenon depended upon

responses associated with the mediator. It appeared reasonable to assume, therefore, that if responses associated with some mediator could mediate a connection between two events, then the nature of these implicit responses should be a factor in the amount of mediation produced. Thus, it could be predicted that concrete nouns, representing some particular object, would differ from abstract nouns, representing no specific object, in the type and possibly the number of responses that were associated with them.

Second, the ability of the individual to form visual images may be a factor in mediated learning. Recent discussions on visual imagery (Leuba, 1940; Mowrer, 1960) have focussed upon the interpretation of visual images as conditioned sensations with the power to function as mediators. How this may be accomplished was suggested by Miller, Galanter, and Pribram (1960) who viewed visual images as associative aids with the capacity to mediate the recall of associates of the mediator. Such a situation would, of course, increase the probability that connections between the mediator and the A-C stimuli would be made. This would especially hold true when the association value of the A-C items was high. Thus, the ability to form visual images in a learning task could be an important factor in determining the amount of learning that takes place.

Delimitations of the Study

1. The subjects used in the study were seventh grade pupils attending Logan Junior High School in Logan, Utah.

2. Visual imagery was studied. Other forms of thought imagery, such as auditory imagery, olfactory imagery, and tactile imagery were not considered.

3. All of the concrete nouns used in the study specified some real object. The abstract nouns, on the other hand, were defined as words not referable to a particular object.

4. The high association value nonsense syllables used were restricted to the 73-87 percent range, while the low association value syllables used were selected from the 13-27 percent range.

Definition of Terms

Concrete and abstract nouns

Concrete nouns were defined as object-referent nouns; that is, as words which refer to a specific object (for example, the word "dog"). Abstract nouns were defined as non-object-referent nouns; that is, as words which do not refer to a particular object (for example, the word "idea").

Mediate association

Mediate association was defined as the process by which two events, never previously associated with each other, acquire some kind of relationship because of their common association with a third event.

Visual imagery

Visual imagery was defined as the process by which objects or events occurring in the experience of the individual could be represented pictorially in the "mind's eye." Within this context,

the terms visualizer and non-visualizer denote an ability of the organism to form visual images. The aptitude for visual imagery was stated in terms of the individual's score on the two identification tests used.

Visualizers were defined as those individuals who obtained scores in the upper fiftieth percentile of the sample, while non-visualizers were those individuals scoring in the lower fiftieth percentile of the sample.

Materials Used in Visual Imagery Testing

The test devices used to identify visualizers and non-visualizers were the Guilford-Zimmerman Visualization Test and the Memory For Designs Test. These instruments provided a means by which the ability of the individual to form visual images could be ascertained objectively.

The use of objective tests to differentiate levels of visual imagery was reported in the studies of Fernald (1912), Carey (1915), Bowers (1932), Lowenfeld (1945), Barrett (1953-54), Drewes (1954), and Radaker (1959). In the latter two investigations, the testing instruments used were somewhat similar to those employed in the present study. Radaker used the Memory For Designs Test as one of his testing devices, while Drewes presented his subjects with designs, then asked them to imagine movements or changes in these designs. This is comparable to the nature of the task required for subjects taking the Guilford-Zimmerman Test.

The Memory For Designs Test

The standardization of this test was conducted in two stages

(Graham and Kendall, 1946; Kendall and Graham, 1948). In the first study, 76 adults were used as subjects. A split-half reliability of .92 for the test was reported for this group. The second study was conducted with 194 children 8 - 15 years old. A test-retest reliability of .80 was reported for 32 of these children. No information about validity was reported in either study. In the standardization of the test, 15 designs were used. The subject's score on the test was determined by how well he could reproduce the designs from memory. The score given for the reproduction of a design was based on a four point scale ranging from zero to three points. A perfect reproduction of any design was assigned a value of zero points. Imperfect reproductions were scored progressively higher.

In the present study, the subject was required to rotate each design in his mind before reproducing it. In Table 6 each design, with the rotation required for it, is illustrated. The designs are shown exactly as they were presented to the subject.

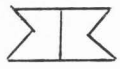
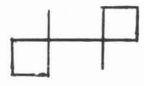
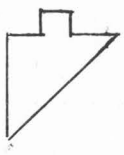
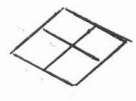
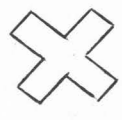
One point was allowed for each correct reproduction of a design. No partial credits were given, including those cases in which the design was correctly drawn but improperly rotated.

The Guilford-Zimmerman Visualization Test

The factor of spatial visualization was defined by Guilford and Zimmerman as follows:

> The factor of spatial visualization seems to involve the process of imagining movements, transformations, or other changes in visual objects. It is a dynamic kind of visualization, whereas another factor identified as visual memory is a static or reproductive visualization. The dynamic visualization factor is represented in tests of

Table 6. A copy of the Memory For Designs Test

Design		Required rotation	Design		Required rotation
1.		None	9.		Turn on its side
2.		Turn upside down	10.		Turn on its side
3.		Turn upside down	11.		Turn upside down
4.		Turn upside down	12.		Turn upside down
5.		Turn upside down	13.		Turn on its side
6.		Turn upside down	14.		None
7.		Turn upside down	15.		Turn upside down
8.		Turn upside down			

> mechanical movements, mechanical comprehension, and in paper folding tests of the Binet type. (Guilford and Zimmerman, 1956, p. 2)

The extent to which the Guilford-Zimmerman Test measures the spatial visualization factor was reported in a study by Michael, Zimmerman, and Guilford (1951). These investigators administered the test to 151 boys and 139 girls, 12 to 20 years of age. The factorial validity reported for the spatial

visualization factor was .60 for boys and .61 for girls.

Data on the reliability and the scoring system for this test were secured from the test manual. The recommended scoring system is based on the formula: $R - \frac{W}{4} =$ total score. The reliability data for approximately 2,650 college men and 1,450 college women were obtained with formula 21 devised by Kuder-Richardson (Garrett, 1962). The test reliabilities reported in the manual were .94 for the men and .93 for the women.

No modifications in the administration and scoring of the Guilford-Zimmerman Test were made in the present study. In Figure 2 a sample item, one of the 40 comprising the test, is presented.

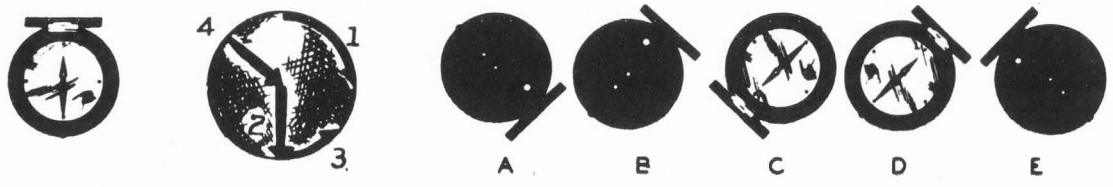


Figure 2. A sample item from the Guilford-Zimmerman Spatial Visualization Test

The subject had to visualize movements of the clock located at the left-hand side of each item. The sphere next to this clock provided information about the movements to be made. The arrows on the sphere indicated the direction and the extent of each movement. In the sample item in Figure 2, four movements of the clock are required. When the last movement was completed, the subject had to select the final position of the clock from

among the alternatives present and mark the answer sheet accordingly.

Test correlation

A product-moment correlation between the Guilford-Zimmerman test scores and the Memory For Designs test scores was computed in this study.

The Materials Used in the Mediate Association Learning Task

In Table 7 the materials used in this phase of the study are shown.

Table 7. The learning materials used in the mediate association phase of the study

A items M value[a]	Mediators B items	Mediators Bx items	Mediators B items	Mediators Bx items	C items M value
High M	Concrete		Abstract		High M
Kis	Pig	Drum	Basis	Innocent	Hyp
Dor	Hay	Radio	Proof	Pressure	Laf
Luv	Doll	Angel	Ideal	Luck	Roc
Mah	Brick	Organ	Extent	Election	Tul
Fer	Tooth	Stove	Scheme	Fund	Wav
Jem	Pencil	Barn	Neglect	Mystery	Gor
	Lamb	Candle	Ambition	Career	
Low M	Jar	Insect	Decision	Grief	Low M
Zer	Duck	Cheese	Failure	Humor	Kag
Vad	Shirt	Meadow	Sympathy	Energy	Bep
Paf	Rabbit	Mirror	Income	Plunge	Zib
Tev	Saddle	Feather	Ability	Mercy	Fup
Nuk					Guh
Kih					Tah

[a]Association value

The mediators depicted in Table 7 were selected from the Thorndike-Lorge list of 30,000 words (1944). Each of the words

appear more than 40 but less than 50 times per million printed words in the materials comprising the Thorndike-Lorge summary count.

The summary count was compiled from four separate counts: The Thorndike General Count which included textbooks, the Bible, and the English classics; the Lorge Magazine Count from recent and popular magazines; the Thorndike Juvenile Count from 120 books recommended for boys and girls in grades three to eight; and the Lorge-Thorndike Semantic Count which was made on a miscellaneous collection of old and recent adult and juvenile reading material.

The nonsense syllables employed as A and C items were selected from the Glaze list. In a 1928 study, Glaze presented a group of 2,019 nonsense syllables to 15 college students tachistoscopically for a period of three seconds per syllable. Subjects were directed to indicate for each syllable whether or not it suggested an association to them. Each of the 2,019 syllables was then ordered along a scale based on the percentage of subjects reporting some association for the syllable. If all 15 subjects reported an association for some item, it was assigned a value of 100 percent. If no subject claimed an association for the syllable, it was given a value of zero percent. Intermediate values for a particular item were assigned in a comparable manner.

The B items shown in Table 7 were used in experimental paradigms, that is, those arranged to permit mediation. The control paradigms contained both B items and Bx items. It was

believed that an arrangement of this kind would provide some sort of baseline condition against which the experimental paradigms could be measured.

Table 7 also contains a complete listing of the A-C nonsense syllables used. Six of the A-C stimulus pairs were selected from the 73-87 percent range of the Glaze list, while the remaining six pairs were selected from the 13-37 percent range.

Materials Used for the Learning Rate List

The materials employed to obtain a measure of each individual's learning rate were Glaze nonsense syllables, selected from the 60-100 percent range. In Table 8, these syllables are shown.

Table 8. The stimuli used in the learning rate test

Bal	Cin	Dek	Ced	Giv	Hom	Pul	Roh
Nuf	Kut	Fab	Haf	Het	Dul	Jun	Rac
Lat	Muc	Mil	Nit	Lic	Pav	Ker	Jok

Selection of Subjects

Seventh grade students attending Logan Junior High School were used as subjects. Altogether, 253 individuals participated in the mediate association phase of the study. Students were not asked to volunteer, nor did they receive rewards or classroom privileges for participating. However, they were told that their performances in the experiment would in no way affect

their school grades. Seventh grade pupils were chosen as subjects for these reasons:

1. The materials to be learned in the mediate association task were geared to their level of comprehension.

2. Pilot work had demonstrated that interest in the task was high for this age group.

General Procedures

Imagery ratings of the mediators

The imagery arousing properties of the mediators were judged in two rating sessions. The first was conducted at Edith Bowen Laboratory School, Utah State University, Logan, while the second took place at Adams Elementary School, also in Logan. The judges were 48 pupils attending the sixth grade at these two schools. The rating sessions took place approximately one month prior to the start of the main study at Logan Junior High.

The concrete and abstract B items shown in Table 7 were rated on a five point scale representing the ease with which that word evoked some visual image. The scale shown in Table 9 was used by the judges to rate the imagery evoking capacities of each B term.

The rating scale was written on the blackboard prior to each rating session. A word was presented to the subjects for a period of 10 seconds. The words were read orally, and then written on the blackboard. After 10 seconds, the word was erased and the next one presented.

Table 9. The scale employed to rate the visual imagery capacities of the B items

Rating scale	Assigned points
No image evoked by the word	0
An image was hard to get for the word	1
An average effort was needed to get an image	2
An image was easy to get for the word	3
An image was very easy to get for the word	4

Table 10 shows the mean visual imagery rating assigned to these words by the judges.

Table 10. The mean visual imagery ratings for the concrete and abstract nouns[a]

Concrete nouns	Mean rating	Abstract nouns	Mean rating
Cheese	3.64	Basis	1.67
Meadow	3.64	Extent	2.03
Insect	3.64	Ability	2.50
Stove	3.67	Income	2.53
Mirror	3.72	Decision	2.57
Drum	3.72	Ambition	2.57
Barn	3.75	Scheme	2.57
Candle	3.75	Sympathy	2.67
Organ	3.78	Ideal	2.67
Saddle	3.82	Failure	2.71
Brick	3.82	Neglect	2.82
Pig	3.82	Innocent	2.89
Lamb	3.85	Proof	2.92
Hay	3.85	Career	2.96
Feather	3.85	Grief	3.00
Angel	3.85	Mercy	3.07
Shirt	3.85	Pressure	3.14
Radio	3.85	Humor	3.17
Tooth	3.85	Fund	3.25
Duck	3.85	Mystery	3.28
Rabbit	3.89	Election	3.39
Pencil	3.96	Luck	3.42
Jar	3.96	Energy	3.42
Doll	4.00	Plunge	3.64

[a]n = 53 independent judgments or ratings

The 12 concrete nouns rated the highest in visual imagery were used as mediators for the E1 paradigms, while the 12 abstract nouns rated the lowest in visual imagery were used as mediators in E2 paradigms. The mean visual imagery rating for the 12 E1 and E2 mediators was 3.90 and 2.37 respectively.

Pilot studies

Several pilot studies, with as few as one or as many as 28 subjects, were conducted prior to the main study. Two of these pilots were, in fact, miniatures of the main study. In each of the pilots, mediation was produced among A-C stimulus pairs associated with a common B item, but not among A-C pairs associated with irrelevant or different B items.

Visual imagery testing procedures

The visual imagery testing periods preceded the mediate association learning task by about six weeks. The testing periods, 11 in all, took approximately 40 minutes per testing period. Altogether, 319 students were tested, with an average of 29 students in attendance at each session.

In general, the subjects appeared to understand the directions given for each test. While it cannot be claimed that each individual participating in the testing was highly motivated, most appeared to be engrossed in the proceedings.

The Guilford-Zimmerman Test was administered first. After the test booklets and answer sheets were distributed, directions were given, and a few sample items demonstrated. Subjects were given 10 minutes to work on the 40 items of this

test.

A design memory test was administered next. The designs were presented to the subjects on 14 x 22 inch white poster boards. Each board contained one design, large enough to be seen clearly in all parts of the room. Each design was shown for five seconds. The directions given for the test were as follows:

> You will be shown a series of 15 cards. Each of these will be shown to you for five seconds. On these cards you will see a design. You are to look at this design for the full five seconds. Then you are to close your eyes and await further instructions from the examiner. Please follow this procedure exactly for each of the 15 cards shown to you. Do not attempt to draw any of the designs until the examiner tells you to do so.

At this point, the first card was shown to the group being tested. Instructions were given to rotate the design mentally in the manner specified in Table 6. The subjects were then directed to open their eyes and draw the design as they last saw it in their minds. The remaining 14 designs were presented in a similar manner.

The subject's visual imagery score was obtained by combining his scores on the Spatial Visualization Test and the Memory For Designs Test. The visual imagery scores were then arranged on two lists, one for each sex, and ordered from the highest score to the lowest. The two lists were then dichotomized at the median to form four lists. The upper portions of both lists being designated as visualizers, while those people in the lower half of each list were designated as non-visualizers. The subjects on these four lists were then assigned to either experimental or control groups. This was done by assigning male and

female visualizers in order to one of these four groups: E1 (experimental one), C1 (control one), E2 (experimental two), and C2 (control two). Male and female non-visualizers were assigned to similar groups in the same manner. Altogether, this resulted in the formation of eight groups. Control groups were formed in the study so that a baseline condition could be developed. This provided a means by which the amount of mediation produced in each experimental group could be determined. The very nature of the task, as well as the unique structure of each experimental group, necessitated the formation of four separate control groups. In Table 11, the number of subjects participating in the mediate association learning task is shown.

Table 11. The number of subjects participating in the mediate association learning task

Group structure	Number of subjects		
	Males	Females	Total
Visualizers			
Experimental one (E1)	15	15	30
Control one (C1)	19	15	34
Experimental two (E2)	20	12	32
Control two (C2)	17	14	31
Non-visualizers			
Experimental one (E1)	19	11	30
Control one (C1)	18	17	35
Experimental two (E2)	15	16	31
Control two (C2)	17	13	30

Lorge-Thorndike Verbal Scale IQ scores for each subject were obtained from the seventh grade files kept at Logan Junior High

School. These were used, when needed, as covariance factors for those hypotheses tested with an analysis of covariance.

Procedures Employed for the Mediate Association Learning Task

The mediate association task was conducted during the regular school hours at Logan Junior High School. Eight learning periods of about 40 minutes each were needed to complete this stage. The first seven learning sessions were conducted on the first day; the eighth on the morning of the second day. The order of treatment was as follows: first day; E1 visualizers, C1 visualizers, E2 visualizers, C2 visualizers, E1 non-visualizers, C1 non-visualizers, and E2 non-visualizers; second day; the C2 non-visualizers.

The treatment accorded to each group consisted of several steps: First, directions for the task were given and a few paired stimuli were shown as examples; second, the A-B and the B-C lists, each containing 12 stimulus pairs, were shown to the subjects; third, mimeographed sheets containing the A-C list were distributed; fourth, a final list consisting of 12 pairs of nonsense syllables was presented. This final list, the same for all subjects, was used to obtain a measure of each individual's learning rate. The learning rate scores were used, when needed, as covariance factors in the statistical analysis of the data. Table 12 shows the experimental design used to present the stimuli to each group.

Table 12. The paradigms used in presenting the stimuli to the experimental and control groups

Group structure	List one	List two	Test list
Experimental groups			
E1 visualizers	A - Bc	Bc - C	A - C
E1 non-visualizers	A - Bc	Bc - C	A - C
E2 visualizers	A - Ba	Ba - C	A - C
E2 non-visualizers	A - Ba	Ba - C	A - C
Control groups			
C1 visualizers	A - Bc	Bxc - C	A - C
C1 non-visualizers	A - Bc	Bxc - C	A - C
C2 visualizers	A - Ba	Bxa - C	A - C
C2 non-visualizers	A - Ba	Bxa - C	A - C

c = concrete words
a = abstract words

It can be seen by reference to Table 12 that experimental paradigms were arranged to permit mediation by using the same mediators in lists one and two. No such provision was made for the control groups. With the controls, new words (Bx items) were introduced into the second list.

E1 and C1 groups were presented with comparable stimulus items. The only difference between the two groups was that C1 subjects were shown a new set of B items in the B-C stage of the paradigm. The B items for both groups were concrete nouns. In Table 13, the complete set of stimuli used with the E1 and C1 groups is shown.

Table 13. The A-B, B-C lists presented to the E1--C1 visualizers and non-visualizers

A-B list		B-C list	
A stimuli	B stimuli	B stimuli	C stimuli
	E1 groups		
Zer	Duck	Duck	Kag
Vad	Brick	Brick	Fup
Tev	Hay	Hay	Bep
Nuk	Pig	Pig	Guh
Kih	Saddle	Saddle	Zib
Paf	Lamb	Lamb	Tah
Fer	Jar	Jar	Wav
Kis	Rabbit	Rabbit	Gor
Luv	Shirt	Shirt	Hyp
Dor	Pencil	Pencil	Laf
Mah	Doll	Doll	Tul
Jem	Tooth	Tooth	Roc
	C1 groups		
Zer	Duck	Angel	Kag
Vad	Brick	Meadow	Fup
Tev	Hay	Radio	Bep
Nuk	Pig	Cheese	Guh
Kih	Saddle	Insect	Zib
Paf	Lamb	Organ	Tah
Fer	Jar	Candle	Wav
Kis	Rabbit	Feather	Gor
Luv	Shirt	Drum	Hyp
Dor	Pencil	Stove	Laf
Mah	Doll	Barn	Tul
Jem	Tooth	Mirror	Roc

E2 and C2 groups were also presented with comparable stimuli. The difference between the gwo groups was that C2 paradigms were not arranged to provide for mediation. The paradigms designed for the E2 and C2 groups differed from those employed with the E1 and C1 subjects in that they contained abstract words in place of concrete words as B terms.

In Table 14, the complete set of stimuli presented to the E2 and C2 groups is shown.

Table 14. The A-B, B-C lists presented to the E2--C2 visualizers and non-visualizers

A-B list		B-C list	
A stimuli	B stimuli	B stimuli	C stimuli
	E2 groups		
Zer	Proof	Proof	Kag
Vad	Neglect	Neglect	Fup
Tev	Failure	Failure	Bep
Nuk	Decision	Decision	Guh
Kih	Sympathy	Sympathy	Zib
Paf	Ambition	Ambition	Tah
Fer	Basis	Basis	Wav
Kis	Ability	Ability	Gor
Luv	Ideal	Ideal	Hyp
Dor	Income	Income	Laf
Mah	Scheme	Scheme	Tul
Jem	Extent	Extent	Roc
	C2 groups		
Zer	Proof	Election	Kag
Vad	Neglect	Grief	Fup
Tev	Failure	Luck	Bep
Nuk	Decision	Fund	Guh
Kih	Sympathy	Humor	Zib
Paf	Ambition	Mystery	Tah
Fer	Basis	Plunge	Wav
Kis	Ability	Innocent	Gor
Luv	Ideal	Mercy	Hyp
Dor	Income	Energy	Laf
Mah	Scheme	Pressure	Tul
Jem	Extent	Career	Roc

The paired stimuli comprising the A-B and B-C lists were printed on 12 x 36 inch light tan cards. Stimulus words were printed in black and were five inches high. It was determined during the course of the experiment that these letters could be seen by each subject. The following directions were given to the subjects prior to the presentation of the A-B and the B-C lists:

> You are going to be shown 12 cards, one at a time. On each card, you will see two words. One of these will be a nonsense word and one of them will be a real word. Your task is to learn to associate the nonsense word

> with the real word. A card will be shown to you for a period of four seconds. Please look at it carefully for the entire time. After you have seen the last card, there will be a 30 second interval. Then you will be presented each of the 12 cards again. As before, you should learn to associate the nonsense word with the real word. Altogether, the 12 cards will be presented to you five times. To make sure you understand what is expected of you, we will demonstrate what you are to do with these sample items.

The A-B list was shown first. The presentation of this list was somewhat as follows: First, each A-B stimulus pair was shown in paired fashion, four seconds for each pair, until all 12 pairs had been shown. Second, at the end of each trial, the cards were randomly shuffled to prevent the occurrence of serial learning effects. Third, the cards were presented four more times in a comparable manner. A period of about three minutes elapsed before the presentation of the B-C list. The procedure followed in showing this list was similar to that used with the A-B list. At this point, the A-C test list was distributed to the subjects. This list was arranged with each A term paired with six C terms. The subject was instructed to circle the C item that had been indirectly associated with the A term during the presentation of the A-B, B-C lists. The matching of A and C terms on the list was done by pairing each of the A stimuli in the upper half of the A-B list with the six C terms that had appeared in the upper half of the B-C list. Each of the A stimuli from the lower half of the A-B list was matched with the six C stimuli from the lower half of the B-C list. The positions of the C syllables next to an A syllable were varied so that no one C syllable appeared in the same position more than once. In Table 15, a copy of the A-C list is shown.

Table 15. The A-C test list used for the eight experimental and control groups

Circle one of the six nonsense words that best fits or goes with the underlined nonsense word to the left. Please answer all items.

Zer	Kag	Guh	Fer	Gor	Hyp	
	Fup	Zib		Laf	Roc	
	Bep	Tah		Wav	Tul	
Vad	Guh	Tah	Kis	Roc	Gor	
	Bep	Fup		Hyp	Wav	
	Kag	Zib		Tul	Laf	
Tev	Fup	Bep	Luv	Hyp	Wav	
	Kag	Tah		Tul	Laf	Did you use images in this
	Zib	Guh		Roc	Gor	
Nuk	Bep	Kag	Dor	Tul	Roc	task?
	Zib	Guh		Wav	Gor	
	Tah	Fup		Laf	Hyp	Yes _____
						No _____
Kih	Tah	Zib	Mah	Laf	Tul	
	Guh	Bep		Roc	Hyp	
	Fup	Kag		Gor	Wav	
Paf	Zib	Fup	Jem	Wav	Laf	
	Tah	Kag		Gor	Tul	
	Guh	Bep		Hyp	Roc	

Reference to Table 15 will show that subjects were asked to indicate whether or not they had used visual images during the learning of the A-B, B-C lists of words.

Procedures Used for the Learning Rate Test

Following the completion of the A-C test for mediation, a final series of 12 paired nonsense syllables were presented. The results from this test were used as a measure of the subject's learning rate. The list was presented for just one trial

with each nonsense syllable pair shown for a period of four seconds. The directions for this task were as follows:

> You will now be shown 12 cards. On each card you will see two nonsense words. Your task is to learn to associate these words with each other. Each card will be shown to you once, for a period of four seconds. Please look at the card for the entire time.

Each of the 12 stimulus pairs was printed on 12 x 36 light tan cards. Stimulus words were printed in black and were 5 inches high. In Table 16, the 12 stimulus pairs comprising the list are shown.

Table 16. The 12 stimulus pairs comprising the learning rate list

Stimulus position	Response position	Stimulus position	Response position
Bal	Het	Cin	Dul
Dek	Jun	Ced	Rac
Giv	Lat	Hom	Muc
Pul	Mil	Roh	Nit
Nuf	Lic	Kut	Pav
Fab	Ker	Haf	Jok

The 12 stimulus pairs shown in Table 16 were presented to the subjects in paired fashion, one at a time. When the last pair had been shown, mimeographed sheets of paper in the form of a recognition test were distributed. Each stimulus item in Table 16 was paired with six of the response items in a manner identical with that used for the A-C test list. The task of the subject was to identify the two nonsense syllables which had appeared together on each of the 12 cards shown to him. In Table 17, a copy of the recognition test is presented.

Table 17. A copy of the recognition test used with the learning rate list

Circle one of the six nonsense words that best fits or goes with the underlined nonsense word to the left. Please answer all items.

Bal	Het	Muc	Pul	Jok	Mil
	Dul	Lat		Pav	Nit
	Rac	Jun		Lic	Ker
Cin	Muc	Het	Roh	Mil	Jok
	Lat	Dul		Nit	Pav
	Jun	Rac		Ker	Lic
Dek	Lat	Jun	Nuf	Pav	Lic
	Muc	Rac		Jok	Ker
	Het	Dul		Mil	Nit
Ced	Jun	Dul	Kut	Lic	Nit
	Rac	Muc		Ker	Jok
	Lat	Het		Pav	Mil
Giv	Rac	Lat	Fab	Ker	Pav
	Jun	Het		Lic	Mil
	Dul	Muc		Nit	Jok
Hom	Dul	Rac	Haf	Nit	Ker
	Het	Jun		Mil	Lic
	Muc	Lat		Jok	Pav

Analysis of the Data

In analyzing the data, operators of the Computer Center at Utah State University randomly eliminated 13 cases from the eight basic groups so as to reduce these to 30 subjects each. The Center did this because its computer programs are designed to function most efficiently on a proportionate basis when comparing groups. The data, therefore, were analyzed for eight groups of 30 subjects per group.

Hypothesis one

An analysis of variance was used to test for significant learning differences between experimental and control subjects. Each of the four experimental groups was first compared with its control on the mean number of correct responses made on the A-C test for mediation. The experimental groups were then combined and compared with the combined control groups on mean A-C scores. The significance of the difference between means was determined by the F test.

Hypothesis two

The function of association value within the experimental paradigms was determined by comparing the amount of mediation produced among the high and low value A-C stimulus pairs. This was done by comparing the mean score differences between experimental and control groups on low value stimuli with the score differential obtained by the same two groups on the high value stimuli. An analysis of variance was used to test this hypothesis. The significance of the difference between experimental and control subjects on the low and on the high value stimuli was determined by the F test.

Hypothesis three

An analysis of covariance was used to determine the significance of the observed difference in the amount of mediation produced by concrete and abstract mediators. This was done by comparing the mean scores made on the A-C test for mediation by the 60 E1 subjects with the scores made by the 60 E2 subjects. The

factor of IQ was covaried with mean scores. The significance of the difference between means was determined by the F test.

Hypothesis four

An analysis of covariance was used to test for significant learning differences between visualizers and nonvisualizers on the A-C mediation test. For the purpose of the analysis, E1 and E2 groups were combined so that 60 visualizers were compared with 60 non-visualizers. The factor covaried in this analysis was IQ. The significance of the difference between mean scores was determined by the F test.

Hypothesis five

An analysis of covariance was used to test for significant learning differences between males and females on the A-C mediation test. Only experimental subjects were compared. The factor of IQ was covaried with mean A-C test scores. The significance of the difference between male and female A-C scores was determined by the F test.

RESULTS

Correlations

The reliability of the Learning Rate Test was determined by the application of Kuder-Richardson's Formula 21 to 240 learning rate measures. The standard deviation for the test was 2.52. A reliability coefficient of .60 was obtained for the test. A reliability coefficient of this magnitude is significant for 240 cases beyond the .01 level of confidence (Garrett, 1962).

A Pearson product moment correlation, also based on 240 cases, was computed between intelligence scores and visual imagery scores. The obtained correlation coefficient of .001 indicates that visual imagery, as measured in this study, is not significantly related to intelligence as measured by the Lorge-Thorndike test. While the "r" between these two measures was low, certain groups being compared differed in mean IQ scores, hence covariance was used where needed.

A Pearson product moment correlation, based on 240 cases, was also computed between the Guilford-Zimmerman Visualization Test and the Memory For Designs Test. The obtained correlation coefficient of .03 is indicative of an insignificant relationship between these two measures.

Data Related to the Hypotheses

IQ and learning rate

Table 18 shows the mean IQ and learning rate scores for the eight groups participating in the study.

Table 18. The mean IQ and learning rate scores for the eight groups participating in the study

Group structure	Number of cases	Mean IQ	Mean learning rate score
Visualizers			
E1[a]	30	113.9	5.7
C1	30	112.9	4.2
E2[b]	30	117.7	4.9
C2	30	122.2	6.7
Non-visualizers			
E1[a]	30	111.5	5.1
C1	30	105.6	4.1
E2[b]	30	104.8	5.8
C2	30	108.5	4.0

[a]Concrete mediators in the paradigm
[b]Abstract mediators in the paradigm

Reference to Table 18 allows the reader to obtain information about the IQ's and learning rate scores of the sub-groups that are discussed in the following pages. The IQ and learning rate scores shown in Table 18 form the basis for the decision of whether or not to use covariance in the analysis of each hypothesis. In comparing the experimental groups, covariance was used whenever the mean IQ or learning rate scores of the groups being compared on an A-C test differed by more than a point.

No covariance was used to compare the mean A-C test responses of experimental with control groups. In the study the

control groups actually provided a baseline, no-learning situation where scores represented random guessing conditions. For this reason it was apparent that covariance would be unnecessary when comparing these groups with experimental subjects even when IQ or learning rate scores differed by more than one point.

The occurrence of mediation, hypothesis one

It was hypothesized that experimental subjects would make more correct responses on the A-C test for mediation than would the controls. Table 19 presents the data used in testing this hypothesis.

Table 19. The mean number of correct A-C test responses made by experimental and control subjects

Group structure	Number of cases	Mean IQ	Mean LR score	Mean number of correct A-C test responses
Experimental	120	112	5.4	4.2
Control	120	112.3	4.8	1.6

The data in Table 19 show that experimental subjects made more correct responses on the A-C test for mediation than did the control subjects. By reference to Table 20 the significance of the difference between the means of the two groups may be seen.

Reference to the treatment source of variation in Table 20 will show the reader that when the mean scores of experimental subjects were compared with those of the controls, the difference between the two means was significant at the .01 level of confidence.

Table 20. The summary table of the factorial analysis of variance data for the mean number of correct responses made by experimental and control groups on the A-C test for mediation

Source of variation	df	Mean square	F
Error	234	4.30	
Visualization	1	75.94	17.66 **
Type (concrete-abstract)	1	36.04	8.35 **
Treatment (experimental-control)	1	382.54	88.96 **
Visualization X type	1	4.53	1.05 NS
Visualization X treatment	1	47.70	11.09 **
Type X treatment	1	42.50	9.88 **
Visualization X type X treatment	1	4.54	1.05 NS
Total	239		

**Significant at the .01 level where .01 = an F of 6.76

The mean A-C test scores of each experimental sub-group were compared with the test scores obtained by the comparable control group. An analysis of variance was then computed between each experimental-control set. Table 21 presents data used for this analysis.

Table 21. The mean number of correct A-C test responses made by each experimental and control sub-group

Group structure	Number of cases	Mean number of correct A-C test responses
Visualizers		
Experimental one[a]	30	6.3
Control one	30	1.7
Experimental two[b]	30	4.1
Control two	30	1.8
Non-visualizers		
Experimental one[a]	30	3.7
Control one	30	1.5
Experimental two[b]	30	2.6
Control two	30	1.6

[a]Concrete mediators in the paradigm
[b]Abstract mediators in the paradigm

The experimental groups obtained higher A-C test scores than the controls in every case. However, the difference in mean scores tended to lessen as the visual imagery abilities of the subject decreased and the structure of the mediator became more abstract. It should be noted in every case that the scores of the control groups were somewhat comparable despite the IQ and learning rate differences between these four groups (refer to Table 18). In Table 22 the analysis of variance data used in determining the significance of the difference between the mean A-C scores of each experimental-control set are presented.

Table 22. The summary table of the analysis of variance data for each experimental group and its comparable control group

Source of variation	df	Mean square	F
Visualizers			
E1 versus C1			
Between means	1	295	49.16 **
Within groups	58	6.03	
Total	59		
E2 versus C2			
Between means	1	101	17.30 **
Within groups	58	5.84	
Total	59		
Non-visualizers			
E1 versus C1			
Between means	1	58	11.60 **
Within groups	58	4.98	
Total	59		
E2 versus C2			
Between means	1	15	6.69 *
Within groups	58	2.24	
Total			

*Significant at the .05 level where .05 = an F of 3.89
**Significant at the .01 level where .01 = an F of 6.76

Reference to Table 22 will show that the difference between the mean scores of each experimental-control set is significant at the .01 level of confidence except for the E2-C2 non-visualizer comparison. The level of significance reached was .05 for this comparison.

Summary, hypothesis one. The mean scores of 120 experimental subjects on the A-C test for mediation were compared with the mean scores obtained by the 120 controls. An analysis of variance was computed to test for the significance of the difference between mean scores. The obtained F ratio indicated significance beyond the .01 level of confidence showing that mediation had occurred with experimental subjects. Support for hypothesis one was also obtained when each experimental group was compared with its own control on mean A-C test scores. The difference between mean scores in most cases was significant at the .01 level of confidence.

Stimulus association value, hypothesis two

It was hypothesized that the amount of mediation produced within the paradigm would be a function of the association value of the A-C stimulus pairs. Table 23 presents the data used in testing this hypothesis.

When high value and low value stimuli were compared as to the amount of mediation produced, the trend was for greater mediation among high value A-C pairs. This trend was consistent irregardless of the nature of the experimental and control groups compared. For example, it mattered little whether experimental and control non-visualizers were compared. In Table 23 the

function of association value in determining the amount of mediation produced can be seen. This table shows that the mean number of correct responses made by experimental visualizers increased from 2.2 to 3.0 as the association value of the stimuli was increased. With non-visualizers, an increase in stimulus association value also produced an increase in the number of correct responses. However, this increase from 1.5 to 1.7 was not as pronounced as that of the visualizers.

Table 23. The mean number of correct responses made by experimental and control sub-groups on high association value and low association value stimuli

Group structure	Number of cases	Mean number of correct responses High value	Low value
Visualizers			
E1 + E2	60	3.0	2.2
C1 + C2	60	.8	.9
Non-visualizers			
E1 + E2	60	1.7	1.5
C1 + C2	60	.7	.8
Concrete type[a]			
E1V + E1NV	60	2.8	2.2
C1V + C1NV	60	.8	.8
Abstract type[b]			
E2V + E2N	60	1.9	1.5
C2V + C2NV	60	.8	.9

[a]Groups with concrete mediators in the paradigm
[b]Groups with abstract mediators in the paradigm

The mean number of correct responses made by E1 groups (concrete type) became greater also as the association value of the stimuli was increased. The mean number of correct responses made by these subjects with low value stimuli was 2.2, increasing

to 2.8 with high value stimuli. On the other hand, a smaller increase was noted for E2 subjects (abstract type) in going from low to high value stimuli. An increase from 1.5 to 1.9 was observed for these individuals.

It should be noted by the reader that none of the control groups showed an increase in the number of correct responses made when the association value of the stimuli was varied. That is, the scores remained approximately the same under both high and low value conditions. The mediational differential between experimental and control groups thus created under high and low value conditions could be tested for significance by an analysis of variance. Table 24 shows the results of this analysis.

Reference to the visualization x treatment source of variation for low value stimuli in Table 24 shows no significant relation between visualization and treatment. However, a comparison of the same two factors under high value conditions show that the relations between the two reach significance at the .01 level of confidence. What this means is that with low value stimuli, the ability to visualize has no advantage with respect to the amount of mediation produced within the paradigm. However, with high value stimuli, the factor of visualization becomes an important determinant in the amount of mediation produced. Thus, in this way, association value is an important factor in determining how much mediation takes place within the paradigm.

Comparable results were obtained when the factors of type and treatment were compared. Reference to this source of variation for high and low value stimuli in Table 24 will show that

the relations between these two factors were significant at the .05 level of confidence with low value stimuli, and that this increased to the .01 level of confidence when the relations between type and treatment under high value stimuli were computed. These results can be taken to mean that as association value within the paradigm increases, concrete mediators become more important factors in determining the amount of mediation that will take place.

Table 24. The summary table of the factorial analysis of variance data for the mean number of correct responses made by experimental and control subjects on high and low value A-C stimuli

Source of variation	df	Mean square	F
Low value stimuli			
Error	232	1.49	
Visualization	1	10.00	6.71 *
Type (concrete-abstract)	1	5.70	3.15 NS
Treatment (experimental-control)	1	57.04	31.57 **
Visualization X type	1	1.21	.81 NS
Visualization X treatment	1	4.54	3.05 NS
Type X treatment	1	8.44	5.66 *
Visualization X type X treatment	1	.10	.07 NS
Total	239		
High value stimuli			
Error	232	1.85	
Visualization	1	30.82	16.66 **
Type (concrete-abstract)	1	13.07	7.06 **
Treatment (experimental-control)	1	144.15	77.81 **
Visualization X type	1	1.06	.56 NS
Visualization X treatment	1	22.81	12.32 **
Type X treatment	1	13.06	7.06 **
Visualization X type X treatment	1	3.28	1.77 NS
Total	239		

*Significant at the .05 level where .05 = an F of 3.89
**Significant at the .01 level where .01 = an F of 6.76

Summary, hypothesis two. The amount of mediation produced within a paradigm was shown to be a function of the association value of the A-C stimuli. Association value was important in the effects it had upon the variables of visualization and type of mediator. As the association value of the A-C stimuli increased, concrete nouns became much better mediators, and the amount of mediation produced within the paradigms of the visualizers sharply increased.

Type of mediator, hypothesis three

It was hypothesized that concrete nouns would be more effective mediators than abstract nouns. Table 25 presents the data used in testing this hypothesis.

Table 25. The mean number of correct responses made by E1 and E2 groups on the A-C test for mediation

Group structure	Number of cases	Mean IQ	Mean LR score	Mean number of correct A-C test responses
E1 groups[a]	60	112.7	5.4	5.0
E2 groups[b]	60	111.3	5.3	3.4

[a]Concrete mediators in paradigm
[b]Abstract mediators in paradigm

The mean number of correct A-C test responses made by the 60 E1 and the 60 E2 subjects was 5.0 and 3.4 respectively. The analysis of covariance summary in Table 26 shows the significance of the difference between these two means.

It can be seen by referring to the type source of variation in Table 26 that the difference between the mean A-C test scores

of the 60 E1 and the 60 E2 individuals reached significance at the .01 level of confidence.

Table 26. The summary table for the factorial analysis of covariance data pertaining to the mean number of correct A-C test responses made by experimental subjects

Source of variation	df	Mean square	F
Error	111	6.84	
Correction term	1	1.40	
Visualization	1	92.35	13.50 **
Type (concrete-abstract	1	77.86	11.38 **
Visualization X type	1	16.21	2.87 NS
Sex	1	19.88	2.81 NS
Type X sex	1	4.35	.63 NS
Visualization X sex	1	5.44	.78 NS
Visualization X type X sex	1	2.07	.30 NS
Covariate	1		
Total	119		

**Significant at the .01 level where .01 = an F of 6.90

Summary, hypothesis three. The hypothesis that concrete nouns would be more effective mediators than abstract nouns was tested by comparing the mean A-C test score of the 60 E1 subjects with the mean A-C test score of the 60 E2 subjects. An analysis of covariance revealed that the difference between the two means was significant at the .01 level of confidence.

The factor of visual imagery, hypothesis four

It was hypothesized that visualizers would make more correct responses on the A-C test for mediation than would the non-visualizers; that is, mediation would be significantly greater for the former individuals. Table 27 shows the data used in testing this hypothesis.

Table 27. The mean number of correct responses made by visualizers and non-visualizers on the A-C test for mediation

Group structure	Number of cases	Mean IQ	Mean LR score	Mean number of correct A-C test responses
Visualizers	60	115.8	5.3	5.2
Non-visualizers	60	108.2	5.4	3.2

The mean A-C test scores for the 60 visualizers and the 60 non-visualizers were 5.2 and 3.2 respectively. Since the two groups differed in EQ, an analysis of covariance, with the factor of IQ covaried, was used to determine the significance of the difference between the two means. Reference to the visualization source of variation in Table 26 shows that the difference between these two means was significant at the .01 level of confidence.

Summary, hypothesis four. The hypothesis that visualizers would make more correct responses on the A-C mediation test was tested by comparing the mean A-C test scores of the visualizers and the non-visualizers. An analysis of covariance between the two means showed the difference between them to be significant at the .01 level of confidence. Since the number of correct A-C test responses was higher for visualizers, support was provided for the hypothesis.

The role of sex differences, hypothesis five

It was hypothesized that there would be no significant learning differences between males and females. The data shown in Table 28 was used to test this hypothesis.

Table 28. The mean number of correct A-C test responses made by males and females

Group structure	Number of cases	Mean IQ	Mean LR score	Mean number of correct A-C test responses
Males	60	111.7	5.1	4.0
Females	60	112.9	5.6	4.3

The mean A-C test scores for the 60 females and the 60 males were 4.3 and 4.0 respectively. The difference between these two means was tested for significance by an analysis of covariance with the factor of IQ covaried. It can be seen by reference to the sex source of variation in Table 26 that the difference between these two means was not significant ($F = 2.81$). The learning rates of the two groups differed somewhat. The mean scores for the 60 females and the 60 males were 5.6 and 5.1 respectively. An analysis of variance computed between these two means was statistically insignificant ($F = 1.9$, $df = 118$), therefore, no covariance on learning rate was carried out.

Summary, hypothesis five. The hypothesis that there would be no significant learning differences between males and females was tested by comparing the mean A-C scores of these individuals. An analysis of covariance was computed between the two means. The results of this analysis revealed that the number of correct responses on the A-C mediation test was not related to sex differences.

DISCUSSION

Correlations

A reliability coefficient of .60 was computed for the Learning Rate Test. The size of this coefficient, while significant at the .01 level of confidence, was somewhat lower than an optimal reliability coefficient. Since the reliability of the test was computed on a restricted sample of the population, group variability would tend to be narrowed. This in turn would reduce the size of the reliability coefficient. In any case, a reliability coefficient of .60 is considered to be adequate for the purposes of distinguishing between groups in research projects (Garrett, 1962). Tests in the 80's or 90's are deemed necessary by Garrett only when predictions or individual diagnoses are to be made.

A Pearson "r" of .009 between total visual imagery scores and Lorge-Thorndike IQ scores for the 240 subjects in the sample indicates an insignificant relationship between these measures. However, the mean IQ scores of the 120 visualizers and the 120 non-visualizers were 116.7 and 107.6 respectively. The difference between these two means was significant at the .01 level of confidence ($F = 27.40$). A closer examination of the two groups revealed no specific intra-group patterns between visual imagery scores and IQ. Within each group, the subject's IQ score was found to be an ineffective predictor of his visual imagery score. Moreover, overlapping between visualizers and non-visualizers in the sub-groups was common; that is, some non-visualizers had

higher IQ scores than some of the visualizers. Thus while each visualizer sub-group did have a higher mean IQ than the non-visualizer sub-groups, an IQ score could not be used as a predictor of the magnitude of the visual imagery score.

The finding that the ability to form visual images could not be predicted from the subject's Lorge-Thorndike IQ score provides support for the results obtained by Carey (1915), Brower (1947), and Drewes (1954). These investigators obtained the IQ's of their subjects with a group intelligence test. Carey and Drewes then used objective tests while brower employed verbal reports to secure a measure of the subject's visual imagery ability. No relationship between IQ and visual imagery was found in any of these studies. However, this does not invalidate the possibility such differences may be found in future investigations. This would be especially true with respect to studies examining various types of visual imagery.

A Pearson "r" of .03 computed between 240 Guilford-Zimmerman and Memory For Designs Test scores would indicate that the tests were measuring different visualization factors. The low correlation between the two tests may be due to the different nature of each task. The Guilford-Zimmerman items, for example, required a minimum of visual memory since the clocks were in view of the subject at all times. However, with the Memory For Designs Test a greater amount of visual memory was required from the subject. In this test, a design was shown to the individual and then removed from view. The person had to maintain a picture of this design in his mind while imagining movements in it.

In their writings, Guilford and Zimmerman (1956) have identified two visualization factors. One of these, spatial visualization, measures the individual's ability to imagine movements in visual objects. This factor is measured by the Guilford-Zimmerman Test. The other visualization factor, a static reproductive one, was identified by the two investigators as visual memory. It is a reasonable assumption that the Memory For Designs Test was essentially a measure of this latter factor.

A second cause for the low correlation between the two tests may be due to the difference in the type of visual objects dealt with in each test. In the Guilford-Zimmerman Test familiar objects like clocks were the materials to be visualized. Conversely, in the Memory For Designs Test, the person was required to visualize unfamiliar designs.

The factorial validity of the Guilford-Zimmerman Test was reported in the test manual as .60 for boys and .61 for girls. No data on validity for the Memory For Designs Test was found in the literature. However, the test does appear to have face validity, and on this basis its use in identifying levels of visual imagery seemed justified.

Data Related to the Hypotheses

The occurrence of mediation, hypothesis one

The nature of the processes taking place in mediation is still a debated question (Jenkins, 1963). The view that these processes involve the transfer of behavioral reactions from one stimuli to another is the one argued in the present discussion.

In a three-stage induced mediation paradigm this would involve the transfer to an A-C set of part of the person's total reaction to the mediator. In this way mediation is "induced" into the A-C set. However, the transfer of these reactions from the mediator to the A or C items first requires that an association be formed between the mediator and each of these stimuli. It has been suggested by Underwood and Schulz (1960) that this task may be aided by the arousal of implicit associative responses (IAR's), some of which are common to both stimuli.

Once the subject learns the associations A-B and B-C, the presentation of A alone should elicit the recall of B which, in turn, should evoke C. By the A-B-C mediation bridge thus formed, the presentation of A should readily lead to C, even though these items had never before been associated. This can occur, of course, only when common mediators are interposed between stimulus pairs. In the current study, the use of "placebo" B items appeared to effectively prevent the formation of a common pathway between each A-C set. Hence, no mediation was observed for any of the control paradigms.

The first mediation study designed for a group learning situation was reported by Cieutat (1962). This investigator obtained mediation for experimental but not for control subjects. Similar findings were later reported by Odom (1965). However, one group study, that of Hakes and Jenkins (1962), did fail to obtain mediation with experimental subjects. Each of these investigations was a frequency association type study. They were, in fact, attempts to replicate the Russell-Storms

(1955) experiment on a group basis. The reasons for the divergence in findings between the three group studies are not apparent since they were comparable in design. The current study is somewhat different in that it was designed as an induced mediation experiment; that is, the A-C items had no apparent relation with each other. Mediation was induced among these stimuli by experimental association. The finding that mediation was produced among all of the experimental paradigms, but not among any of the controls, provides support for the notion that mediation can be induced into a paradigm in a group learning situation.

Stimulus association value, hypothesis two

The amount of mediation produced within each experimental paradigm was found to be a function of the associative frequency of the individual words on the list. These findings are in agreement with those reported by Peterson and Blattner (1963) and by Horton (1964). In the latter study, real words and nonsense words were compared as mediators. It was found that more mediation was produced in those paradigms using real words.

The Peterson-Blattner (1963) study was comparable to the current investigation in that the associative frequency of the A-C stimuli was varied systematically in an A-B, B-C, A-C paradigm. It was found that more mediation was produced with high than with low association value stimuli.

The current finding that more mediation was produced among stimuli of higher associative frequency could be explained by recourse to associative probability. The number of associates of a word elicited in a set interval is presented as the

associative frequency of that word. High frequency words have more associates than low frequency words. Therefore, when these are compared in a mediation paradigm, the arousal of common associates of the mediator and A-C items should be more likely for high frequency stimuli. In this way more, and possibly stronger, A-B-C mediation bridges are to be expected for high frequency stimuli.

Type of mediator, hypothesis three

Bowers (1929) was among the first investigators to study the relation between the rated imagery of a word and the ease with which it was learned. He found a direct relation between the two; that is, the words assigned a higher visual imagery rating were the easiest to learn. Similar results were also obtained by Bugelski (1962). This investigator asked college students to learn lists of words varying in association value. Later, each student was asked to rate these words on their imagery evoking properties. Bugelski found that the words rated the highest in visual imagery were the ones most easily learned. These relationships were also studied by Paivio (1965), whose subjects rated groups of concrete and abstract nouns on visual imagery, and found that concrete nouns were assigned a high visual imagery rating. Paivio then constructed paired-associate lists of noun-noun pairs and presented them to his subjects to learn. Some of the lists were composed of concrete nouns while others were made up of abstract nouns. It was found by Paivio that it took fewer trials for his subjects to learn the noun-noun connections when

they were concrete.

The results obtained in the current study indicate that the visual imagery rating assigned to the mediator is a factor in mediate association. The concrete nouns, which were given a higher imagery rating by the 53 judges, were more effective mediators than the abstract nouns. This would be the expected finding if one accepts the view of Miller, Galanter, and Pribram (1960) that visual images have the power to mediate the recall of associates of the mediator. There is, however, another way of viewing this question. It is possible that concrete nouns, since they have a specifiable object-referent, normally acquire more associates than abstract nouns. In either case, the final result would be the same. The increase in the strength or the number of connections thus formed between the mediator and each stimulus of the A-C set would make it more likely that more effective mediation bridges would be formed with concrete mediators.

The finding that concrete nouns were more effective mediators was contrary to that reported by Paivio and Yarmey (1965), who compared concrete and abstract mediators in an A-B, C-B, A-C paradigm. Concrete words were found to be only slightly superior as mediators. However, the two kinds of nouns were compared only on the response side of the paradigm. In previous studies by Paivio (1963), and by Yarmey and Paivio (1965), it had been demonstrated that concrete nouns were superior to abstract nouns in a paired-associate learning task only when these were compared on the stimulus side of the list. The current study did provide a method by which concrete and abstract nouns could be compared

on the stimulus side of the paradigm.

The factor of visual imagery, hypothesis four

The individuals classified as visualizers in the present study made the highest scores on the A-C test for mediation, providing some evidence for the suggestion that visual imagery can be a factor in mediate association. The visualizer, assuming that he makes use of his ability, could utilize the visual image as an aid in recalling associates of the mediator (Miller, Galanter, and Pribram, 1960). In this way the probability of a connection being formed between the mediator and an A or C item would be substantially increased, thus resulting in a greater amount of mediation in the paradigm.

Verbal reports were obtained from experimental subjects ascertaining to what extent the visualizer used his ability. Of the 60 visualizers questioned, 33 reported using visual images in the learning task, while 27 reported they did not. With respect to the 60 non-visualizers, the number of subjects in each category was 20 and 40, respectively. It would appear, therefore, that the visualizers as a group were inclined more toward the use of visual images. On this basis it might be argued that the greater use of images by the visualizer group served to mediate the recall of a greater number of associates of each mediator resulting in a greater number of mediation bridges being formed among this group as compared to the non-visualizer group.

The present findings on visual imagery as a factor in learning are in agreement with those reported earlier by Radaker (1959). This investigator found that a person's visual imagery

ability could be improved by training, and could then be an aid in facilitating the individual's recall of word forms. The implication suggested by Radaker's study is that the ability to form visual images improves a subject's learning efficiency. In essence, this implication is supported by the current findings.

The role of sex differences, hypothesis five

No significant learning differences were found between the males and females participating in this study. Both groups made a comparable number of correct responses on the A-C test for mediation. The findings suggest that these boys and girls have acquired a somewhat comparable stock of implicit responses to the stimuli used in the paradigm. It is not surprising that this should be so, if one considers the restricted sample used in the study. It would be reasonable to assume that the boys and girls, taken as a group, had comparable opportunities for exposure to the stimuli. Therefore, similar reactions to them would be expected.

The Physiological Basis of Mediation

Any discussion of the physiological mechanisms underlying mediation can be speculative only, since the physiological basis of learning is beyond our comprehension at the present time. However, part of the story is familiar to physiologists. It is known, for example, that receptor mechanisms are fired by energy emitted by the stimulus object. The nerve impulses formed then travel down neural pathways to receiving centers in the cerebrum. By a process not understood at the present time, these impulses

are integrated with information already possessed by the person to lend meaning to the stimulus he is perceiving. Most physiologists believe that the nerve impulses upon arriving in the cerebral cortex produce some neural change in that organ. Whether the change is electrical, chemical, or both, is not known. However, the neural change, whatever its form, has been called a memory trace, and is considered to be responsible for all stimulus-response connections developed by the individual.

In the terminology of Hebb (1949), the memory trace is considered to be a reverberatory circuit capable of maintaining neuronal excitation in the cerebral cortex long after the receptor mechanisms have ceased firing. Hebb has postulated a highly sophisticated associationistic model of learning based on the concepts of the "cell assembly" and the "phase sequence." A cell assembly is a functional unit in the cerebral cortex composed of many interconnected neurons. In essence, cell assemblies are developed whenever the individual perceives some enrionmental event. A single assembly is the neurological correlate for only a small portion of the total stimulus situation. Furthermore, assemblies are strengthened and become well established through repeated experiences with the stimulus. As the assemblies develop through practice, neurons lying in close prosimity develop the ability to fire each other thus maintaining neuronal activity even though external excitation has ceased. Hebb has referred to these self-stimulating circuits as reverberatory circuits.

The perception of the total experience in Hebbian theory is accounted for by reference to phase sequences or assemblies

of cell assemblies. The psychic representation of the phase sequence can be referred to as an idea. Whenever the individual focusses upon a complex stimulus pattern, each component of the pattern activates a cell assembly in the cerebral cortex. The formation of cell assemblies occurs in a sequential pattern in the cerebral cortex as the subject fixates upon each component in the total stimulus pattern. The phase sequence thus formed represents an association of many cell assemblies each functionally related. Therefore, the activation of one assembly of the sequence will initiate activity in the entire sequence. The facilitative effect of one assembly upon another is directly related to the number of times these are contiguously presented to the person. The repetitive activation of related cell assemblies gradually results in the integration of the assemblies into what Gestalt psychologists would call "wholes" or patterns.

In terms of Hebb's theory, induced mediation involves the association of ideas by the development of functionally related phase sequences. For example, in a chaining paradigm of the form A-B, B-C, A-C, closely related sequences are formed in the cerebral cortex for each A-B-C term. The sequences formed become more firmly associated neurally with each contiguous presentation of the terms to the subject. Eventually, the presentation of the A term should activate its corresponding phase sequence, which, in turn, should activate phase sequences corresponding to terms A and C. In this manner, the presentation of the A term alone initiates a series of neural events which should enable the person to recall term C via the A-B-C chain previously developed.

SUMMARY AND CONCLUSIONS

Introduction

The views of Bugelski and Sharlock (1952), Mowrer (1960), and Jenkins (1963) on the importantce of mediation in symbolic forms of behavior were given some emphasis in this paper. The position taken by each investigator was that the process of mediation has great potential value as a technique for the experimental analysis of learning, thinking, and insight. It was further stressed that there had been too little research in psychology on mediated learning. The views of these learning specialists seemed to suggest a need for the current study.

The stated purpose of the investigation was to examine the function of visual imagery, type of mediator, and associative frequency in an induced mediation paradigm of the form A-B, B-C, A-C. The role of each factor in mediation was studied in a group learning situation. Boys and girls were studied separately so that some measure of the importance of sex differences in mediate association could be obtained.

In a synopsis of the mechanics of mediate association, it was stressed that this process was a form of indirect association; that is, two events acquired equivalence, not through contiguous presentation, but by common association with a third event.

Statement of the Hypotheses

After considering the pertinent literature on mediate association, these hypotheses were made:

1. Experimental subjects will make more correct responses on the A-C mediation test than the controls.

2. The amount of mediation occurring in experimental paradigms will be a function of the associative frequency of the A-C stimuli.

3. Concrete nouns will be more effective mediators than abstract nouns.

4. Visualizers will make more correct responses on the A-C mediation test than the non-visualizers.

5. There will be no significant learning differences between the males and females.

Methods and Materials

The Guilford-Zimmerman Visualization Test and the Memory For Designs Test were given to 319 seventh grade students. The scores for each subject on these tests were combined to give that person's visual imagery score. The visual imagery scores for the 319 students were then arranged according to sex on one of two lists from the highest score to the lowest. Each list was then dichotomized at the median to form visualizer and non-visualizer lists. Each visualizer, male and female, was then assigned, in the order that their names appeared on a list, to one of four treatments. These were: experimental one (E1), control one (C1), experimental two (E2), and control two (C2).

A similar assignment was made of the male and female non-visualizers, resulting in the formation of eight groups. The four experimental groups were then compared with the four control groups in a mediate association learning task. Each group received training on two paired-associate lists (the A-B, B-C lists), and was then tested on an A-C list to determine if mediation had occurred. The experimental paradigms differed from the controls in the arrangement of the B terms. With experimental subjects, common B items were used in the first two lists, while with controls irrelevant B terms were arranged across the two lists.

The B items employed with experimental one and control one groups were concrete nouns. Conversely, abstract nouns were used as B items with the experimental two and the control two groups. However, the same A-C Glaze nonsense syllables were used with all groups. Six of the A-C pairs used were high associative frequency syllables from the 73-87 percent range. The remaining six pairs were low associative frequency syllables from the 13-27 percent range.

The A-B list was shown first for five trials. The 12 stimulus pairs comprising this list were presented in paired fashion, with each pair shown for a period of four seconds. The B-C list was then presented in a similar manner. The stimulus pairs were printed in large black letters on light tan cards, and held up to the subject's view. At this point, the A-C list was distributed to the subjects. This list was arranged with each of the A terms matched with six C terms. The

individual was required to circle the C term which had been indirectly associated with the A term on the two training lists. With control paradigms, of course, the subject could only guess which C item was the appropriate one.

The Lorge-Thorndike IQ and a learning rate score were obtained for each subject. These were used, together with A-C test responses, as covariance factors when the IQ's or the learning rate scores of the groups being compared differed significantly. Otherwise, the hypothesis was tested with an analysis of variance.

Results

The results obtained with respect to each of the hypotheses tested were as follows:

1. Mediation was obtained with each of the four experimental paradigms. Conversely, an examination of the four control groups revealed that no mediation had occurred in these paradigms. The "guessing" situation that prevailed with these groups was shown by the comparable A-C test scores obtained.

2. The amount of mediation produced within experimental paradigms was found to be a function of the associative frequency of the A-C stimuli. Maximum mediation was obtained with high frequency stimuli. A survey of the number of correct A-C test responses made by control groups showed no difference between high and low frequency syllables in these paradigms.

3. It was found that concrete nouns were more effective mediators than abstract nouns; this was true for both the

visualizers and the non-visualizers.

4. The amount of mediation produced within experimental paradigms was found to be a function of the visual imagery ability of the subject. Visualizers made more correct responses on the A-C mediation test than did the non-visualizers. This occurred for paradigms employing either concrete or abstract mediators.

5. No significant learning differences were found between the boys and the girls participating in the study.

Conclusions

The results of this study provided support for the position that mediation can be experimentally "induced" into a paradigm, and that these effects can be obtained in a group learning situation. Although the results reported in the literature on these facets of mediation are conflicting, the weight of the evidence is comparable to the current findings. Thus, it would appear that by the proper arrangement of stimuli within the paradigm, mediation can be produced. Furthermore, the process can be regulated or inhibited by the use of "placebo" B terms in the second list.

The amount of mediation obtained in a paradigm proved to be a function of the visual imagery abilities of the subject, the type of mediator used, and the associative frequency of the A-C stimuli. Each of these variables, taken singly, influenced the amount of mediation produced. However, the effects of these variables appeared to be additive within the paradigm. A survey

of the results indicated that a trend or pattern existed between the various arrangements of the three variables in the paradigm and the amount of mediation produced. For example, maximum mediation was obtained with high associative frequency stimuli in E1V paradigms (visualizers and concrete mediators). Conversely, a minimum amount of mediation was obtained with low associative frequency stimuli in E2NV paradigms (non-visualizers and abstract mediators). Other combinations of these three variables resulted in intermediate amounts of mediation being produced. From these findings one might conclude that optimal results may be obtained with "induced" mediation paradigms when the subject is a visualizer and the materials to be learned are rich in associations and imagery evoking capacities.

The finding that males and females did not differ appreciatively in the number of correct A-C test responses suggests a comparable learning background for these two groups. In a task presumed to depend on covert responses this would indicate that the boys and girls had developed similar response patterns to the materials presented.

Recommendations

Several implications for classroom teaching are suggested by the findings of the present study. For example, the recommendation might be made that in helping the child to develop his stock of concepts, the teacher should emphasize the liberal use of imagery evoking materials in concept formation tasks. Although visualizers would be expected to profit most from the

use of materials rich in imagery, such materials should also make the concept formation task easier for non-visualizers. It might further be suggested that meaningful materials be employed in the concept learning task. Apparently, some combination of meaningfulness and imagery in the learning materials will provide optimal conditions under which concept formation can occur.

The research emphasis in mediated learning at the present time is upon discovering the factors which activate, inhibit, or otherwise influence the process. In keeping with current research interests and pertinent to the findings of the present study, some suggestions for further research could be made.

1. The process by which verbal mediating responses are inhibited is a fertile area for investigation. For example, the role of intervening variables in inhibiting the subject's mediating responses could be studied in association chaining paradigms. The effects of emotional conditioning upon mediation could be studied by associating some aversive stimuli with the inferred mediators prior to list learning. Presumably then, when learning the A-B, A-C lists, the emotional reactions conditioned to the inferred mediators would inhibit the recall of these mediators by the subject. Thus, the chaining process commonly observed would not occur.

The position may also be taken that emotional illness would be a factor in inhibiting an individual's verbal mediating responses. The disturbances in the subject's perceptual processes concommitant with the confusion in memory and conceptualization that occurs would probably inhibit the recall of the proper

mediating responses when the subject is confronted with a particular stimulus situation. The effects of emotional disturbance upon mediation could be studied by comparing emotionally disturbed and normal subjects in any of the more common mediation paradigms.

2. The factors which activate mediating responses may also be studied by recourse to mediation paradigms. For example, the role of visual imagery set could be investigated by asking the subject to hold the image suggested by the mediator in his thoughts during list learning. The position might be taken that such a procedure would result more easily in the formation of A-B-C connections.

The role of developmental age as a factor in mediation has received little attention in research. Presumably, the number and kind of mediators which the subject acquires depends upon his former experiences. The mediating responses developed from each experience depend, in part, upon the age of the subject. It might be suggested that developmental studies be conducted at various age levels to provide some information about the age at which the subject obtains various kinds of verbal mediators.

3. The further analysis of concrete and abstract mediators in induced mediation paradigms may be recommended. Perhaps such abstract terms as liquid, animal, and furniture could be compared with concrete terms such as milk, horse, and table. The prediction could be made that superordinate concepts would be more effective mediators since, presumably, these terms have subsumed more categorical data than subordinate concepts.

4. The role of creative thinking in mediation would appear to be an area worthy of investigation. Creative thinking, as herein defined, implies originality, fluency, and flexibility in the individual's thought processes. The thinking of the creative person is exploratory, venturesome, and uninhibited. Supposedly, the creative thinker is able to rearrange existing knowledge to form new thoughts, ideas, or concepts. In mediated learning, especially problem-solving situations, the creative person's divergent thinking abilities would be a decided advantage. Presumably it would not be necessary for the divergent thinking individual to directly experience the events which are to become the mediators in the problem-solving situation. Instead, the necessary mediating responses could be created from existing knowledge already possessed by the person.

The ability of the divergent thinking individual to create mediators may be ascertained experimentally by arranging problem-solving situations that would allow him to demonstrate these abilities. In problem-solving tasks, information would be given to the learner which by itself would not provide the solution to the problem, but would allow the learner to create mediators that would lead to the correct solution.

The nature and extent of the verbal mediating chains that could be produced by the creative individual would also appear to be an area worthy of study. Since the creative person is known to possess associational fluency, it may be possible to demonstrate mediation with these subjects using inferred mediators several links removed from the explicit terms in the chain.

Present research findings obtained with association chaining paradigms have demonstrated mediation chiefly with simple B-C-D association chains.

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APPENDIX

Table 29. The complete visual imagery testing data and mediate association data for each individual participating in the study

Subject code[a]	IQ	G-A[b] test	MFD[c] test	Total V score	LR[d] score	Mediate association test scores: HA[e] items	LA[f] items	Total
				E1 Visualizers				
1FE1V	98	5.50	7	12.50	5	1	3	4
2FE1V	119	10.00	9	19.00	6	3	1	4
3FE1V	112	4.25	12	16.25	3	3	1	4
4FE1V	107	7.75	6	13.75	5	2	3	5
5FE1V	106	5.00	8	13.00	10	6	1	7
6FE1V	112	12.25	9	21.25	4	6	6	12
7FE1V	115	5.75	10	15.75	12	3	1	4
8FE1V	84	7.25	7	14.25	2	2	2	4
9FE1V	127	9.50	8	17.50	9	5	6	11
10FE1V	110	12.75	12	24.75	7	4	1	5
11FE1V	108	3.50	8	11.50	4	3	1	4
12FE1V	127	7.25	8	15.25	1	5	2	7
13FE1V	128	12.00	12	24.00	8	5	6	11
14FE1V	120	5.00	9	14.00	6	5	3	8
15FE1V	112	6.75	6	12.75	4	6	3	9
1ME1V	88	15.50	10	25.50	4	2	2	4
2ME1V	121	10.75	8	18.75	2	2	3	5
3ME1V	136	15.75	13	28.75	7	3	3	6
4ME1V	84	9.25	10	19.25	4	0	3	3
5ME1V	88	10.75	8	18.75	8	5	4	9
6ME1V	102	13.75	11	24.75	2	1	1	2
7ME1V	135	11.25	12	23.75	12	6	1	7
8ME1V	100	9.50	7	16.50	2	3	1	4
9ME1V	121	10.50	11	21.50	2	0	1	1
10ME1V	130	20.25	14	34.25	5	6	3	9
11ME1V	127	17.00	7	24.00	5	4	3	7
12ME1V	132	8.75	11	19.75	8	1	1	2
13ME1V	111	13.00	9	22.00	5	6	0	6
14ME1V	129	10.00	7	17.00	12	6	6	12
15ME1V	128	17.00	10	27.00	8	6	6	12
				C1 Visualizers				
1FC1V	116	8.25	11	19.25	2	0	0	0
2FC1V	114	3.75	8	11.75	3	0	0	0
3FC1V	89	10.00	6	16.00	3	0	1	1
4FC1V	138	16.50	12	28.50	8	1	4	5
5FC1V	99	8.75	9	17.75	3	1	0	1
6FC1V	134	-.25	12	11.75	2	0	0	0
7FC1V	114	7.25	8	15.25	6	2	0	2
8FC1V	114	7.75	4	11.75	2	2	0	2

Table 29. Continued

Subject code[a]	IQ	G-A[b] test	MFD[c] test	Total V score	LR[d] score	Mediate association test scores: HA[e] items	Mediate association test scores: LA[f] items	Mediate association test scores: Total
9FC1V	106	5.00	12	17.00	4	0	2	2
10FC1V	122	6.25	8	14.25	4	1	3	4
11FC1V	133	9.50	9	18.50	5	0	0	0
12FC1V	124	2.50	11	13.50	7	1	0	1
13FC1V	120	7.00	10	17.00	8	1	0	1
14FC1V	97	6.50	6	12.50	2	0	4	4
15FC1V	98	5.75	6	11.75	5	0	2	2
16FC1V	112	5.50	11	16.50	3	1	0	1
17FC1V	130	5.75	7	12.75	4	0	0	0
18FC1V	132	9.00	10	19.00	10	1	0	1
19FCiV	112	4.00	8	12.00	4	1	0	1
1MC1V	110	3.75	12	15.75	2	4	1	5
2MC1V	87	9.50	9	18.50	3	1	1	2
3MC1V	116	15.00	8	23.00	2	2	2	4
4MC1V	112	10.25	11	21.25	3	0	0	0
5MC1V	95	11.50	8	19.50	3	0	0	0
6MC1V	108	11.00	9	21.00	6	1	0	1
7MC1V	121	14.50	9	23.50	2	0	0	0
8MC1V	114	10.75	14	24.75	7	1	1	2
9MCiV	111	21.00	10	31.00	5	1	2	3
10MC1V	107	9.25	6	15.25	8	1	0	1
11MC1V	125	18.00	13	31.00	2	1	0	1
12MC1V	130	14.75	12	25.75	6	2	1	3
13MC1V	108	7.25	11	18.25	5	1	1	2
14MC1V	103	8.75	7	15.75	3	0	1	1
15MC1V	121	16.50	13	29.50	6	0	2	2
E2 Visualizers								
1FE2V	123	12.75	6	18.75	5	2	1	3
2FE2V	109	6.50	8	14.50	6	3	1	4
3FE2V	88	2.75	9	11.75	6	4	1	5
4FE2V	122	11.75	7	18.75	7	4	1	5
5FE2V	126	9.00	8	17.00	5	2	2	4
6FE2V	129	17.00	5	22.00	7	0	2	2
7FE2V	117	8.75	3	11.75	3	1	1	2
8FE2V	145	8.75	13	21.75	6	2	0	2
9FE2V	112	5.50	7	12.50	5	3	1	4
10FE2V	112	7.75	8	15.75	6	0	2	2
11FE2V	119	1.75	14	15.75	2	4	1	5
12FE2V	132	7.00	6	13.00	9	6	2	8
1ME2V	120	13.00	10	23.00	3	4	1	5
2ME2V	121	13.75	10	23.75	6	6	6	12

Table 29. Continued

Subject code[a]	IQ	G-A[b] test	MFD[c] test	Total V score	LR[d] score	Mediate association test scores: HA[e] items	LA[f] items	Total
2ME2V	112	12.00	11	23.00	4	0	3	3
4ME2V	131	15.75	10	25.75	3	2	1	3
5ME2V	122	20.00	8	28.00	3	0	1	1
6ME2V	125	8.75	7	15.75	6	1	2	3
7ME2V	132	16.50	7	23.50	6	3	2	5
8ME2V	115	10.25	9	19.25	5	3	2	5
9ME2V	121	10.75	10	20.75	3	2	1	3
10ME2V	127	3.50	12	15.50	4	0	1	1
11ME2V	115	10.75	12	22.75	3	2	2	4
12ME2V	102	8.75	7	15.75	6	4	4	8
13ME2V	104	12.50	9	21.50	2	1	0	1
14ME2V	89	8.00	10	18.00	5	2	4	6
15ME2V	106	18.50	7	25.50	4	4	2	6
16ME2V	125	15.75	12	27.75	4	4	3	7
17ME2V	127	8.75	10	18.75	6	0	1	1
18ME2V	104	15.75	10	25.75	8	2	1	3
19ME2V	136	11.00	7	18.00	2	5	4	9
20ME2V	110	20.50	11	31.50	8	2	0	2
				C2 Visualizers				
1FC2V	127	11.75	3	14.75	6	3	1	4
2FC2V	126	7.50	10	17.50	2	2	0	2
3FC2V	140	10.00	11	21.00	8	1	0	1
4FC2V	119	5.50	8	13.50	10	0	1	1
5FC2V	112	6.00	6	12.00	3	0	3	3
6FC2V	142	9.50	12	21.50	11	1	1	2
7FC2V	126	11.00	12	23.00	10	1	1	2
8FC2V	112	3.00	10	13.00	7	1	0	1
9FC2V	123	14.25	6	20.25	11	1	1	2
10FC2V	124	8.75	6	14.75	6	0	1	1
11FC2V	118	5.25	7	12.25	9	1	0	1
12FC2V	112	8.25	5	13.25	7	1	0	1
13FC2V	108	11.00	9	20.00	3	1	0	1
14FC2V	130	12.00	8	20.00	6	1	2	3
15FC2V	129	10.25	9	19.25	9	1	3	4
16FC2V	129	11.00	13	23.00	12	1	3	3
17FC2V	138	6.00	15	21.00	12	1	2	3
1MC2V	106	6.25	8	14.25	6	0	1	1
2MC2V	119	10.25	8	18.25	4	0	2	2
3MC2V	140	16.00	8	24.00	4	2	2	4
4MC2V	117	9.75	10	19.75	7	0	0	0
5MC2V	125	11.25	4	15.25	5	1	1	2
6MC2V	118	11.00	9	20.00	3	1	0	1

Table 29. Continued

Subject code[a]	IQ	G-Ab test	MFD[c] test	Total V score	LR[d] score	Mediate association test scores: HA[e] items	LA[f] items	Total
7MC2V	124	15.75	12	27.75	7	2	0	2
8MC2V	121	22.50	9	31.50	6	0	2	2
9MC2V	126	8.00	8	16.00	9	1	0	1
10MC2V	107	14.00	7	21.00	7	2	0	2
11MC2V	133	13.25	10	23.25	6	0	1	1
12MC2V	136	8.75	14	22.75	8	0	1	1
13MC2V	92	8.75	8	16.75	4	0	2	2
14MC2V	125	20.00	14	34.00	6	1	0	1
				E1 Non-visualizers				
1FE1NV	105	5.00	6	11.00	4	4	1	5
2FE1NV	114	2.50	5	7.50	4	3	0	3
3FE1NV	117	4.50	7	11.50	7	3	1	4
4FE1NV	111	3.50	4	7.50	7	1	1	2
5FE1NV	115	3.75	5	8.75	4	1	0	1
6FE1NV	127	1.00	8	9.00	3	1	0	1
7FE1NV	115	4.00	7	11.00	6	1	2	3
8FE1NV	136	1.25	7	8.25	9	6	5	11
9FE1NV	128	3.50	5	8.50	7	6	5	11
10FE1NV	115	2.50	2	4.50	4	1	2	3
11FE1NV	96	3.50	5	8.50	5	2	0	2
12FE1NV	105	.75	8	8.75	6	1	1	2
13FE1NV	90	4.75	4	8.75	7	1	1	2
14FE1NV	110	3.00	8	11.00	7	6	3	9
15FE1NV	118	5.00	5	10.00	3	2	1	3
16FE1NV	122	-2.75	5	2.25	3	2	1	3
17FE1NV	117	3.75	6	9.75	5	0	2	2
18FE1NV	130	1.50	7	8.50	9	6	6	12
19FE1NV	104	2.50	3	5.50	3	1	2	3
1ME1NV	124	1.50	7	8.50	5	0	2	2
2ME1NV	126	3.00	7	10.00	8	2	1	3
3ME1NV	114	2.50	7	9.50	2	2	1	3
4ME1NV	102	6.75	6	12.75	3	0	1	1
5ME1NV	104	5.00	8	13.00	4	0	1	1
6ME1NV	107	5.00	6	11.00	5	0	2	2
7ME1NV	92	3.75	9	12.75	4	0	2	2
8ME1NV	86	6.00	5	11.00	7	3	1	4
9ME1NV	90	1.75	4	5.75	2	2	2	4
10ME1NV	119	7.25	7	14.25	7	1	3	4
11ME1NV	107	3.25	4	7.25	4	1	2	3

Table 29. Continued

Subject code[a]	IQ	G-A[b] test	MFD[c] test	Total V score	LR[d] score	Mediate association test scores: HA[e] items	Mediate association test scores: LA[f] items	Mediate association test scores: Total
			C1 Non-visualizers					
1FC1NV	114	.50	6	6.50	0	1	1	2
2FC1NV	123	6.00	4	10.00	2	1	1	2
3FC1NV	88	3.25	8	11.25	3	0	1	1
4FC1NV	100	5.00	6	11.00	6	0	0	0
5FC1NV	96	3.00	6	9.00	4	1	1	2
6FC1NV	105	.75	8	8.75	4	1	0	1
7FC1NV	121	5.00	4	9.00	1	0	1	1
8FC1NV	130	4.75	5	9.75	6	1	0	1
9FC1NV	116	3.75	5	8.75	3	1	2	3
10FC1NV	110	3.25	6	9.25	6	1	3	4
11FC1NV	112	1.50	5	6.50	3	1	1	2
12FC1NV	112	-3.75	6	2.25	5	2	0	2
13FC1NV	105	5.00	2	7.00	6	1	0	1
14FC1NV	124	2.00	6	8.00	1	2	1	3
15FC1NV	103	1.75	2	3.75	4	1	0	1
16FC1NV	102	-1.00	8	7.00	2	0	0	0
17FC1NV	105	2.25	5	7.25	8	0	0	0
1MC1NV	105	2.50	6	8.50	4	0	0	0
2MC1NV	108	4.75	9	13.75	5	2	1	3
3MC1NV	134	6.50	6	12.50	4	0	0	0
4MC1NV	77	.75	13	13.75	2	1	0	1
5MC1NV	73	-1.50	4	2.50	6	0	0	0
6MC1NV	98	.25	8	8.25	2	2	1	3
7MC1NV	121	9.00	5	14.00	6	1	1	2
8MC1NV	84	3.75	7	10.75	9	0	3	3
9MC1NV	98	2.50	8	10.50	7	1	0	1
10MC1NV	107	3.00	2	5.00	1	1	1	2
11MC1NV	113	3.00	8	11.00	8	0	0	0
12MC1NV	119	5.25	7	11.25	4	1	1	2
13MC1NV	100	0.00	6	6.00	2	0	0	0
14MC1NV	96	5.00	5	10.00	3	1	1	2
15MC1NV	77	2.00	7	9.00	6	0	0	0
16MC1NV	89	6.50	8	14.50	2	1	1	2
17MC1NV	103	3.00	3	6.00	1	1	1	2
18MC1NV	191	-.25	4	3.25	4	2	1	3
			E2 Non-visualizers					
1FE2NV	110	2.50	6	8.50	9	1	1	2
2FE2NV	113	2.50	7	9.50	5	0	2	2
3FE2NV	105	-.25	5	4.75	5	0	2	2
4FE2NV	123	1.50	9	10.50	5	1	1	2
5FE2NV	95	1.75	6	7.75	5	0	2	2
6FE2NV	81	1.50	9	10.50	6	1	1	2

Table 29. Continued

Subject code[a]	IQ	G-A[b] test	MFD[c] test	Total V score	LR[d] score	Mediate association test scores: HA[e] items	Mediate association test scores: LA[f] items	Mediate association test scores: Total
7FE2NV	114	5.75	4	9.75	6	2	1	3
8FE2NV	112	-2.00	4	2.00	9	1	2	3
9FE2NV	118	2.75	6	8.75	10	3	1	4
10FE2NV	129	3.25	5	8.25	5	2	2	4
11FE2NV	93	.50	2	2.50	4	2	1	3
12FE2NV	86	-1.25	4	2.75	9	1	1	2
13FE2NV	98	-1.75	6	4.25	7	4	1	5
14FE2NV	82	2.50	1	3.50	4	1	0	1
15FE2NV	112	3.25	7	10.25	6	1	2	3
16FE2NV	109	3.75	5	8.75	6	2	1	3
1ME2NV	88	5.50	9	14.50	3	4	2	6
2ME2NV	110	.50	7	7.50	5	2	2	4
3ME2NV	119	-.25	7	6.75	4	0	0	0
4ME2NV	134	8.75	5	13.75	8	1	2	3
5ME2NV	123	2.25	12	14.25	3	0	0	0
6ME2NV	102	3.50	6	9.50	6	1	0	1
7ME2NV	90	3.00	6	9.00	7	3	1	4
8ME2NV	99	4.00	4	8.00	6	4	2	6
9ME2NV	100	-1.25	4	2.75	6	1	0	1
10ME2NV	77	0.00	10	10.00	7	1	4	5
11ME2NV	111	6.50	2	8.50	5	0	0	0
12ME2NV	124	2.25	4	6.25	3	3	2	5
13ME2NV	97	4.25	9	13.25	6	0	1	1
14ME2NV	105	5.00	3	8.00	5	2	1	3
15ME2NV	93	2.50	12	14.50	4	0	0	0
			C2 Non-visualizers					
1FC2NV	104	-2.50	7	4.50	1	0	1	1
2FC2NV	108	-1.00	7	6.00	4	1	0	1
3FC2NV	118	2.50	4	6.50	3	0	2	2
4FC2NV	97	1.50	7	8.50	5	1	0	1
5FC2NV	101	3.75	6	9.75	2	1	0	1
6FC2NV	89	1.75	3	4.75	1	2	0	2
7FC2NV	90	2.25	3	5.25	1	0	2	2
8FC2NV	115	.25	5	5.25	5	0	0	0
9FC2NV	121	2.50	7	9.50	4	1	2	3
10FC2NV	125	2.25	5	7.25	5	2	2	4
11FC2NV	128	4.50	6	10.50	6	1	0	1
12FC2NV	103	2.25	4	6.25	6	0	2	2
13FC2NV	110	6.25	4	10.25	6	1	1	2
14FC2NV	118	.75	6	6.75	10	1	0	1
15FC2NV	107	3.75	4	7.75	6	2	0	2

Table 29. Continued

Subject code[a]	IQ	G-A[b] test	MFD[c] test	Total V score	LR[d] score	Mediate association test scores: HA[e] items	LA[f] items	Total
16FC2NV	132	3.50	4	7.50	4	0	0	0
17FC2NV	102	3.25	4	7.25	4	0	0	0
1MC2NV	117	4.00	10	14.00	6	0	0	0
2MC2NV	107	6.75	5	11.75	0	0	0	0
3MC2NV	106	5.25	5	10.25	6	0	0	0
4MC2NV	91	4.75	10	14.75	3	1	1	2
5MC2NV	118	4.50	6	10.50	3	1	1	2
6MC2NV	110	-1.25	10	8.75	4	0	1	1
7MC2NV	118	3.00	5	8.00	5	0	1	1
8MC2NV	98	5.50	6	11.50	5	0	3	3
9MC2NV	109	1.50	5	6.50	1	1	3	4
10MC2NV	121	1.75	8	9.75	5	1	0	1
11MC2NV	85	3.25	8	10.25	1	0	1	1
12MC2NV	105	5.50	9	14.50	5	1	2	3
13MC2NV	102	7.00	5	12.00	3	3	1	4

[a]F = Female M = Male
[b]Guilford-Zimmerman Test
[c]Memory For Designs Test
[d]Learning Rate Score
[e]High Association Value A-C
[f]Low Association Value A-C

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VISUAL IMAGERY AND LEVEL OF MEDIATOR ABSTRACTNESS IN INDUCED MEDIATION PARADIGMS

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Summary.—Two objective tests, presumed to measure *S*'s ability to form visual images, were administered to 240 seventh grade students. On the basis of test scores, equal numbers of *S*s were assigned to visualizer and non-visualizer categories. *S*s in each category were now assigned at random to one of four conditions and their performance compared in a mediate association learning experiment. Paradigms were designed to compare visualizers and non-visualizers on learning tasks which used concrete and abstract nouns as mediators. The findings showed that mediation was related both to the type of mediator used in the paradigm and *S*'s ability to visualize.

Numerous studies have shown that mediation can be induced experimentally. Apparently, pre-formed associations are not a necessary requirement for the occurrence of mediation. Shipley (1933), for example, using conditioning techniques, developed associations among stimuli for his *S*s during the course of his experiments. *S* learned a simple motor response (eyeblink) which served to mediate a second motor response (finger withdrawal to a light flash).

Although an early attempt to demonstrate induced mediation using verbal materials as stimuli produced ambiguous findings (Peters, 1935), many later investigators reported positive results (e.g., Bugelski & Sharlock, 1952; Kaplan, 1959; Kjeldergaard & Horton, 1961; Seidel, 1962).

The role of visual imagery in mediate association has received little attention. Writings of Leuba (1940) and Mower (1960) on visual imagery point out the need for such research. Mower especially has focused upon an interpretation of a visual image as a conditioned sensation with the power to function as a mediator in learning. Miller, Galanter, and Pribram (1960) have suggested that visual images may function as mediators in learning tasks by stimulating the recall of associates.

Level of word abstractness in paired-associate learning has been studied by Bugelski (1962), Paivio (1963), and Yarmey and Paivio (1965). These studies compared word pairs which differed in their capacity to evoke visual images among participating *S*s. The results of these studies indicated that word pairs highest in the capacity to evoke images were the most easily learned. A mediate association study by Paivio and Yarmey (1965) comparing high and low imagery-evoking mediators yielded similar results. The present study was designed to compare high and low imagery-evoking nouns as mediators in a mediate association paradigm of the form A-B, B-C, A-C. An innovation was the control of *S*'s ability to form visual images.

METHOD

Subjects

Ss were 240 seventh-grade students attending school in Logan, Utah. Eight groups of 30 *Ss* were formed in the experiment. Each group was composed of approximately equal numbers of boys and girls. None of the students received remuneration or grade credits for participating in the study. Lorge-Thorndike IQ scores were available for all 240 *Ss*.

Design and Materials

Ss were given the Guilford-Zimmerman Spatial Visualization Test (Guilford & Zimmerman, 1956) and the Memory-for-Designs Test (Kendall & Graham, 1948; Graham & Kendall, 1956). The former was scored according to standard directions. On the 15-design Memory-for-Designs one point was credited for each correct reproduction of a design. The scores obtained by each *S* were combined to give a visual imagery score. The 120 *Ss* with the highest visual imagery scores (range 15 to 34 points) were designated as visualizers ($M = 22.3$). The remaining 120 *Ss* (range 0 to 14 points) were designated as non-visualizers ($M = 9.7$). *Ss* from the two categories were then assigned separately at random to one of four conditions: experimental groups one and two (E_1, E_2) and control groups one and two (C_1, C_2). Since visualizers and non-visualizers were grouped separately, there were eight groups.

Each group received 5 training trials on two 12-pair paired-associate lists (the A-B, B-C lists). The word pairs comprising each list were printed on 12- $\times$ 36-in. cards—one S and one R member per card. The experimental paradigms differed from the controls, in that common B terms were arranged across the two training lists. In control paradigms, different B terms were used in the two lists.

Concrete nouns (e.g., pig, jar, doll, pencil) were used as B terms with E_1 and C_1 groups. These words had previously been rated high in imagery by 48 seventh graders not participating in this experiment. Abstract nouns (e.g., ideal, income, energy, humor) were used as B terms with all E_2 and C_2 groups. The abstract words had been rated low in imagery by the 48 judges. Both types of mediators were selected from Thorndike and Lorge's (1944) list of 30,000 words and were equated for frequency of usage in the materials comprising the Thorndike-Lorge Summary Count. The nonsense syllables which formed the A-C stimuli in the two training lists were 13 to 87% association value syllables from the Glaze (1928) list.

A recognition task was used to test for mediation. On the A-C test sheet designed for this were the 12 A and 12 C terms used in the two training lists. Each A term was paired with six of the C terms. The pairing of A and C terms was done by matching each of the A stimuli in the upper half of the A-B list with the six C stimuli appearing in the upper half of the B-C list. A similar pairing was arranged for each of the A terms appearing in the lower half of the A-B

list. Each of these was matched with the six C stimuli from the lower half of the B-C list.

Procedure

Eight learning sessions, each with 30 *Ss* attending, were conducted in classrooms provided by the schools. *Ss* were seated so that all could see the stimulus cards as they were held up to view.

The A-B list was presented first five times (trials). At the end of each trial, the 12 cards making up the list were shuffled to prevent the occurrence of serial learning effects. Each card was shown for 4 sec. Approximately 1 min. elapsed between the presentations of the trials. At the end of the fifth presentation of the A-B list, sheets of paper were distributed to experimental *Ss*. On each sheet, the 12 A terms were listed. *S* was asked to recall the appropriate B terms. This procedure provided *E* with a measure of the learning rate for each *S* on the A-B list. The B-C list was then shown. The procedure followed was comparable in all respects to that used in showing the A-B list. After 5 trials, a mimeographed sheet of paper containing the A-C test sheet was distributed to each *S*, and *Ss* were directed to underline the C term which had been indirectly associated with an A term on the A-B, B-C training lists.

Results and Discussion

The number of correct responses made by E_1 and E_2 groups on the two training lists were averaged for each group. The results are shown in Table 1.

An analysis of variance, using simple randomized design (Lindquist, 1953, pp. 47-66), between the mean scores obtained by the four experimental groups on each training list revealed no significant learning rate differences among experimental *Ss* on either training list (A-B list $F = .80$, $df = 3/116$; B-C list $F = .56$, $df = 3/116$).

TABLE 1

MEAN NUMBER OF CORRECT RESPONSES MADE BY EXPERIMENTAL *Ss* ON A-B, B-C TRAINING LISTS ($N = 30$ PER GROUP)

Condition		Training Lists	
		A-B List	B-C List
Visualizers	E_1	8.6	7.4
	E_2	8.4	7.6
Non-visualizers	E_1	8.3	7.6
	E_2	8.5	7.5

The A-C test scores made by experimental and control *Ss* were averaged for each group. Mean scores were used as a basis of comparison in determining the roles of visual imagery and level of mediator abstractness in the experiment.

TABLE 2

MEAN NUMBER OF CORRECT RESPONSES MADE BY EACH EXPERIMENTAL AND CONTROL GROUP ON A-C TEST SHEET ($N = 30$ PER GROUP)

Condition		Number of Correct Responses on A-C Test Sheet
Visualizers	E_1	6.3
	C_1	1.7
	E_2	4.1
	C_2	1.8
Non-visualizers	E_1	3.7
	C_1	1.5
	E_2	2.6
	C_2	1.6

Table 2 shows the mean scores obtained for experimental and control groups. IQ was eliminated as an experimental variable by covarying *Ss*' A-C test scores with Lorge-Thorndike IQs whenever groups being compared differed by more than 1 IQ point (cf. Lindquist, 1953, pp. 317-327).

To demonstrate mediation, the A-C test scores of the four experimental groups were averaged (4.2) and compared with the mean score made by the four control groups combined (1.6). An analysis of variance between means indicated significant mediation for experimental *Ss* beyond the .01 level of confidence ($F = 88.96, df = 1/238$).

The effectiveness of concrete vs abstract mediators was determined by comparing the mean correct A-C test responses of the 60 E_1 (5.0) and the 60 E_2 (3.4) *Ss*. An analysis of covariance (covaried for IQ; Lindquist, 1953, pp. 317-327) showed concrete nouns to be more effective mediators than abstract nouns ($F = 11.48, df = 1/118, P = .01$). The finding that learning was more effective in paradigms containing imagery-evoking materials was similar to the data reported by other researchers (Bugelski, 1962; Paivio, 1963; Paivio & Yarmey, 1965). It is altogether possible that words which can evoke images other than an image of the word itself can more easily be learned because of the multiplicity of ways such words can be incorporated into the learning experiences of the individual.

The effect of the visualizer variable in the mediation process was examined by comparing the mean correct A-C test responses of the 60 experimental visualizers (5.2) with the 60 experimental non-visualizers (3.2). An analysis of covariance (covaried for IQ) showed that visual imagery was a factor in the magnitude of the mediation produced ($F = 13.50, df = 1/118, P = .01$).

Results showing that visualizers scored significantly higher on the A-C test sheet than non-visualizers suggest that an individual's ability to form visual images is a factor in mediated association. If the assumption is made that visual-

izers used their ability during the experiments, the superior performance of these *Ss* can be explained by recourse to the hypothesis of Miller, Galanter, and Pribram (1960). Miller, *et al.* hypothesized that visual images have the power to mediate the recall of the mediator or associates of the mediator in verbal learning tasks. Perhaps it is also logical to assume that the use of imagery reinforces the verbal connections made by *S* between members of each A-C pair.

In any event, the results clearly showed the magnitude of the mediation effect to be a function of both the type of mediator employed in the paradigm, and *S*'s ability to form visual images. Maximum mediation was obtained with visualizers in paradigms in which concrete nouns were employed as mediators. Conversely, minimum mediation was obtained with abstract mediators in paradigms designed for non-visualizers.

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