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THE EFFECTS OF VISUAL AND VERBAL REHEARSAL ON RECALL AND RECOGNITION OF PICTURES: A DEVELOPMENTAL STUDY

by

PENELOPE J. HAILE

A dissertation submitted to the Graduate Faculty in Education in partial fulfillment of the requirements for the degree of Doctor of Philosophy, The City University of New York.

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Abstract

THE EFFECTS OF VISUAL AND VERBAL REHEARSAL ON RECALL AND RECOGNITION OF PICTURES: A DEVELOPMENTAL STUDY

by

Penelope J. Haile

Adviser: Professor Barry J. Zimmerman

Paivio (1971) proposed a concept of memory which stresses the availability of two distinct, yet interdependent memory systems, one verbal and one non-verbal. The verbal system represents and processes information in linguistic units. The non-verbal system represents and processes information as images.

Efforts to delineate the process similarities and differences between the verbal and non-verbal systems have led to consideration of the status of a rehearsal mechanism in the two systems. Paivio (1971) suggested the possibility of a visual rehearsal mechanism which would have properties roughly analogous to the rehearsal mechanism in verbal memory.

The results of research on visual rehearsal are equivocal, particularly with regard to visual rehearsal in children. The present study addressed a number of

sets of questions about visual and verbal rehearsal strategies. The basic design used was a 3 x 4 x 4 repeated measures design with three levels of instructional conditions (verbal, visual, and control), four levels of grade (kindergarten, three, six, and college), and four levels of blank time intervals (interstimulus intervals of 1, 3, 6, and 9 seconds). There were two dependent measures: a free recall test and a two-alternative forced-choice recognition test.

One hundred forty-four students individually viewed 60 pictures of familiar objects. One third of the students were randomly assigned to the verbal instructional condition in which they were directed to say aloud the name of each object as it was shown, then to silently repeat as many of these names as they could during the time between the picture presentations. Another third of the students were randomly assigned to the visual instructional condition in which they were told to form an image in their minds of each picture as they saw it and to repeat, in their minds, as many of these images as they could during the time between the picture presentations. The final third of the students were randomly assigned to the control condition in which they were only told to remember as many pictures as they could. No memory strategy was suggested.

The present study found that recognition performance does improve with age, although the development of visual memory through the school years is far more gradual than is the development of verbal memory. However, the results of the present study cast doubt on the Paivio hypothesis that there is a rehearsal mechanism within the imagery channel which directly parallels verbal rehearsal in the verbal channel. Recognition performance did not improve with instructions to subjects at four age levels to use a strategy of visual rehearsal of images of the pictorially presented stimuli. Verbal rehearsal instructions, however, significantly improved both the recall and the recognition of pictures by third graders.

The implications of these findings for education are discussed.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Chapter I

Introduction

A vast amount of the time and effort of educational psychologists has been spent on the study of verbal information processing. Most theories of school learning are based on principles of paired-associate learning, verbal memory, and prose learning. M. M. Haith (1971) wrote:

> The tendency for so many investigators to concentrate on verbal encoding and rehearsal to the exclusion of purely visual processing is probably related to the extensive activity in the area of verbal-learning, but even more importantly, to the almost exclusive use of stimulus materials, letters and numbers, which adults are biased to encode verbally. And psychologists' historical need to model internal processes after externally observable behavioral activity has probably played no small role in this regard. (p. 256)

This preference for the verbal is quite understandable. Schooling, traditionally, is conceived of as facility with the written word and the accumulation of an integrated body of verbal knowledge. The role played by images in intelligence has received very little attention. The most probable reasons for this, apart from the empiricists' natural reluctance to consider imagery, are the common beliefs that 1) images convey limited, specific information, 2) images of any complexity are immediately verbally coded for storage in memory, and 3) images of any complexity need to be verbally coded in order to be "comprehended."

Jean Piaget's (1971) book Mental Imagery in the Child, however, suggests that images play a fundamental role in children's memory and intellectual development. Piaget and Inhelder (1971) wrote:

> . . . preoperational images, just as any other kind of images, will promote the acquisition, or at least the fixation and consolidation of data . . . if the image had not contributed to the actual discovery [of conservation] at least it had served to fix it in the memory, to consolidate it, and to facilitate further observation. (pp. 376-377)

And speaking of the function of images in operational thought, Piaget (1971) noted:

> The image then constitutes an auxiliary that is not only useful to, but in many instances necessary for the functioning of the operations. After having structured and fashioned it in their own likeness, the operations in fact come to depend on the image. (p. 378)

Piaget (1971) went on to state that images do not constitute thought itself, but serve as symbolic instruments of thought, in much the same way as language. Thus, images stand for and signify cognitive content. Images and language are both tools of thought with independent qualities and functions. The study of children's memory, and intellectual development in general, cannot be complete without examination of the role played by images.

Recent attention to imagery has come from the behaviorist camp as well. For behaviorist investigators (e.g., Paivio, Yuille, Lesgold, Anderson), as it is for Piaget, images are conceived of as fractional components of a sensory perception. These images are not the same as the images inscribed on the "wax tablet" as envisioned by Plato. They are only a partial reconstruction by the individual of sensory input. As Neisser (1967) quipped, "Imagery is not a matter of opening old file drawers, but of building new models" (p. 146).

Broadly speaking, images can be auditory, visual, sensori-motor or any other non-verbal sensory construction which takes place without the presence of the external stimulus. Images, as such, are differentiated from after-images (also called icons by Neisser, 1967) which are the immediate fading traces of a sensory input. The life of any visual after-image lasts up to a maximum of two seconds after the cessation of the stimulus (Neisser, 1967). The life of an image can be the lifetime of the individual. Thus, an image is any sensory, non-verbal information stored in memory over time. Most studies of images, however, deal exclusively with visual images. The following discussion and study will deal only with visual images.

Much of the interest in imagery in the 1960s and early 1970s has concentrated on the mediational and facilitative role played by images in verbal learning. More recently, attempts have been made to study the image process as such rather than studying imagery as a mediational adjunct to verbal learning. This work has included efforts to relate images to such well-established constructs as short-term and long-term memory, encoding strategies, and rehearsal strategies. Rehearsal of visual images, defined as the continued encoding of an image after the cessation of the external stimulus, has very recently received some long-overdue attention.

The use of rehearsal as a verbal memory strategy has been shown to improve retention. Flavell and his associates (Flavell, 1970; Flavell, Beach, & Chinsky, 1966; Flavell, Friedrichs, & Hoyt, 1970) have demonstrated that children's memory for verbal content can be enhanced with instructions to verbally rehearse the items.

Experimental evidence on visual rehearsal is not as persuasive. Early studies by Potter and Levy (1969) and Shaffer and Shiffrin (1972) showed that cognitive processing of a visual display takes place only during the time that the visual display is being viewed by the subject. Further processing or rehearsal of the item does not continue into a blank time period during which the item is no longer visible. More recent studies by Tversky and Sherman (1975) and Weaver (1974) have found that increasing the blank time period for adults viewing complex pictures resulted in increased retention of these pictures. Tversky and Sherman (1975) and Weaver (1974) concluded that rehearsal or further processing of the pictures was taking place during the blank time.

While visual rehearsal can be demonstrated with adults, Haith (1971) suggested that visual rehearsal is not used spontaneously by children. If children do not use visual rehearsal as a memory strategy, perhaps, with instructions to do so, they will be able to improve their visual memory through the use of visual rehearsal.

The Problem

The present research investigated, across ages, three specific sets of questions which aimed to broaden our understanding of the nature, strength, and extent of visual rehearsal. The questions addressed in the present study were:

Question Set I: Is there a process of visual rehearsal which can be thought of as roughly analogous to the process of verbal rehearsal in short-term memory? Is the process similar in children and adults?

Question Set II: What is the nature or form of visual rehearsal? Is it affected by the subject's age?

Question Set III: Are instructional sets capable of affecting developmental differences in rehearsal capability? How responsive to instructions are visual codes? Do instructional sets have a differential effect on types of retention tests? Will there be a facilitative effect for children when a "match" exists between input or storage mode and retrieval cues or retention test form?

Chapter II

Review of the Literature

Verbal Rehearsal

The concept of rehearsal of previously encoded verbal material is well-documented. There is extensive evidence that verbal information continues to be coded, rehearsed, and transferred to long-term storage well after the cessation of the physical presentation (e.g., Aaronson, 1967; Rundus, 1971). Rehearsal has been defined by Kintsch (1970) as "repeated passage through the same limited-capacity channel (i.e., short-term memory)" (p. 147). He suggested that rehearsal improves retention. The memory model of Waugh and Norman (1965) also implies that storage in long-term memory requires rehearsal. Kintsch's concept of rehearsal is limited to verbal rehearsal, facilitated by verbal labeling (p. 163). He assumes that a stimulus must be coded with a verbal label before it can be rehearsed. Norman (1969) noted that Sperling (1967) views rehearsal not only as a vocal (i.e., verbal) process, but as a serial process with a subvocalization rate of three to six words per second.

In their model of memory, Atkinson and Shiffrin (1968) also postulate an explicit rehearsal mechanism and assume that learning will occur when an item is rehearsed.

They demonstrated that the physical exposure time of any verbal item does not affect retention of this item. They assumed that verbal rehearsal, which can occur both during an interstimulus interval and during the presentation of subsequent items, maintains these verbal items in memory long after the exposure time.

Visual Memory

Other authors have suggested that there may be analogous encoding processes for visual information. However, supportive evidence is not as clearcut. Recent studies suggest that visual information and verbal information are processed, stored in memory, and retrieved in different ways. Consistent differences in amount of recall of pictures and words have been demonstrated. Snodgrass and McClure (1975) presented adults with sets of pictures and sets of words. After an inspection phase, the adults were asked to describe what they had just seen (free recall test). The results showed that the pictures were recalled better than the words. Bird and Bennett (1974) also found superior recall of pictures than words for children 4, 6, 8, and 10 years old. Memory capacity for pictures is far greater than for words. Pictures do not seem to suffer from the limitations in memory capacity as do verbal items (Shepard, 1967; Standing, Conezio,

& Haber, 1970; Haber, 1970). Hoffman and Dick (1976) reported a retention rate at a better than chance level for 300 pictures presented to 3-year-olds. Also, images do not seem to respond to sequential order effects and serial position effects as do words (Warren, Obusck, Farmer, & Warren, 1969; Potter & Levy, 1969; Shaffer & Shiffrin, 1972).

These data lend support to a concept of memory which stresses the availability of two distinct, yet interdependent memory systems, one verbal, one non-verbal. Such a model of memory has been proposed by Paivio (1971, 1974). Paivio (1974) clearly outlined his dual coding approach. He wrote:

> The most general assumption is that verbal and non-verbal information are represented and processed in distinct but interconnected symbolic systems. I intend this in the strong sense, that the two systems are functionally independent. At the same time, it is necessary to assume that the systems are partly interconnected so that activity in one system can initiate activity in the other. A second general assumption is that the nature of the symbolic information differs qualitatively in the two systems. Specifically, one system is specialized for representing and processing information concerning nonverbal objects and events in a rather direct, analog fashion. Imagery is a unique expression of its functioning, so it is convenient to refer to it as the imagery system. The other is specialized for dealing with linguistic units and generating speech, so let us call it the verbal system. The qualitative distinctions extend to the organization of information in the two systems. The imagery system organizes elementary images into higher-order structures so that the informational

> output of the system has a synchronous or spatial character, whereas the verbal system organizes linguistic units into higher-order sequential structures. Finally, rather than being static representations, both systems are capable of functioning in a dynamic and flexible way to reorganize, manipulate, or transform cognitive information. When this occurs, the transformations are governed by the structural features of the information in each system. Thus, dynamic visual imagery involves transformations of such visual and spatial attributes as size, location, and orientation of imagined objects, whereas verbal transformations involve sequential rearrangements of words and other linguistic units. (p. 8)

Recent studies have made initial efforts to test aspects of Paivio's dual coding hypothesis. Experimental evidence to support the basic notion of dual channel encoding has been presented by Bencomo and Daniel (1975), Parks and Kroll (1975), Pellegrino, Siegel, and Dhawan (1975), and Kosslyn, Holyoak, and Huffman (1976). Arthur and Daniel (1973) found that test items calling for cross-modal responses (visual presentation to verbal test or vice versa) required additional processing time. Powell, Hamon, and Young (1975) suggested that dual encoding is amenable to instructional set. In their paired-associate (PA) learning experiment, half of the adult subjects were instructed to use verbal mediation to facilitate later recall of the response item when presented with the stimulus item of each pair. The remaining half of the adults were instructed to use imagery mediation to facilitate later recall. Interpolated tasks were inserted between presentations of successive PA pairs during the study phase. The two interpolated tasks used were a shapes selection task and a name-of-shapes selection task. The results lend support to Atwood's (1971) basic notion of selective interference. Selective interference occurred when the processing mode (verbal or imagery, as controlled by the instructions) used in the learning task was the same as the mode used in the interpolated task. Powell, Hamon, and Young (1975) concluded that:

> The results of the present experiment indicate that verbal materials can be learned and encoded in a mode activated by verbal-mediation instructions or in a mode activated by imaginal instructions. Furthermore, a concurrent task in a different mode--either verbal or imaginal--may be processed with relatively little decrement occurring in learning performance. (p. 477)

Thus, the coding mechanism itself is not dependent upon stimulus characteristics entirely. The coding channel used by subjects appears to be amenable to instructions.

Snodgrass and McClure (1975) also found differential effects for instructional set. Adult subjects were instructed either to image or to verbalize to both word and picture stimuli. The instructions were used to control the storage channel (either verbal or visual) used by the subjects. A recognition memory test was used in which some stimuli appeared in their opposite form (i.e., some previously studied words were tested with their corresponding pictures and vice versa). Recognition performance for pictures was identical under the two instructional conditions, suggesting that adults automatically dually encode simple pictures. However, imagery instructions improved the recognition of words, while verbal instructions did not improve recognition of the pictures. These results suggest that while adults automatically double code simple pictures, they do not generally double code words. In this situation, instructions to image will enhance word retention.

Visual Rehearsal

Further efforts to delineate the process similarities and differences between the verbal and nonverbal systems have led to consideration of the status of a rehearsal mechanism in the two systems. Paivio (1971, pp. 131 and 160) suggested the possibility of a visual "rehearsal" mechanism which would have properties roughly analogous to the rehearsal mechanism in verbal memory. The evidence, however, is equivocal.

Posner and Konick (1966), using a dot location on a line as the memory task, found that memory over time was high unless an interference task was interpolated in a delay period between stimulus presentations (blank time).

Presumably, the interference task prevented rehearsal. In this case, however, Posner and Konick drew on a broad definition of rehearsal put forth by Broadbent (1958). Posner and Konick (1966) noted:

> According to [Broadbent's view], rehearsal is a recycling process which requires a portion of the processing capacity of the subject. . . . it would be meaningful to talk about rehearsal of material in nonverbal form if it were shown to require a portion of the subject's processing capability. (p. 72)

The evidence for rehearsal of more complex stimuli is contradictory and controversial. Potter and Levy (1969) found that the longer the presentation time for rapidly presented complex pictures, the more information was stored. As they increased the rate of exposure from 1/8 to 2.0 seconds, the probability of a correct recognition increased from .16 to .93. These findings are in direct contrast to those found by Atkinson and Shiffrin (1968) for verbal stimuli, as discussed on Page 8. Potter and Levy (1969) concluded that visual stimuli are processed one by one only during presentation. This may suggest that visual rehearsal is not possible. The implication is that there is no further processing of the stimuli.

Proponents of a concept of visual rehearsal could argue that rehearsal was not being tested here because the experimental paradigm did not permit the use of a possible visual rehearsal mechanism. The paradigm used by Potter and Levy (1969) included rapid presentation of the stimuli. There was no blank time between stimuli in which rehearsal could be engaged in by the subjects. Another plausible explanation for the Potter and Levy (1969) results is backward masking, a well-established characteristic of visual memory (Kahneman, 1968; Raab, 1963; Sperling, 1960, 1963). Backward masking, as described by Neisser (1967), takes place when a later visual input masks or obscures the after-image of a previous stimulus. Thus, the image is distorted or eradicated in the initial phase of processing.

Shaffer and Shiffrin (1972) controlled for backward masking by inserting a blank time between presentations of complex visual stimuli. Their findings showed that blank time of at least one second in duration had no effect on the recognition of visual material. Thus, even with backward masking controlled by the insertion of an interstimulus interval, visual rehearsal effects were again not evident. Shaffer and Shiffrin (1972) concluded ". . . there can be no analog of verbal rehearsal in the visual memory system that can be applied to moderately complex visual stimuli" (p. 295).

Lutz and Scheirer (1974) questioned the apparent lack of any blank time effect in the Shaffer and Shiffrin (1972) study. The implication of this absence of effect is that no rehearsal of any sort (verbal or visual) was possible for visual stimuli more complex than a dot location on a line. The stimuli used by Shaffer and Shiffrin (1972) were 120 color and black-and-white slides of pictures such as furniture, outdoor scenes, machinery, and paintings. Lutz and Scheirer (1974) surmised that these stimuli made it difficult for the subjects to generate unique one-word verbal labels for each picture. Lutz and Scheirer (1974) hypothesized that the absence of a blank time effect on retention reported by Shaffer and Shiffrin (1972) could be attributed to the unavailability of unique verbal labels for the stimuli. In order to test this hypothesis, Lutz and Scheirer (1974) used 190 black-and-white 35-mm slides photographed onto 16-mm film. The pictures were of common objects such as a clock, radio, and spoon. Presentation times were .25, .50, 1.00, and 2.00 seconds and blank times were .25, 1.00, and 2.00 seconds. Verbal labeling and a verbal rehearsal strategy were further encouraged by the use of a between-groups factorial design in which each group in the study had one presentation time and one blank time. In this way, the subjects were able to anticipate the duration of each stimuli, as well as the intertrial interval. A consistent strategy was, thus, encouraged. Shaffer and Shiffrin (1972), while using almost the same presentation times

(0.2, 0.5, 1.0, 2.0, and 4.0 seconds) and blank times (1.0, 2.0, and 4.0 seconds), used a within-group design.

A third aspect of the Lutz and Scheirer (1974) study was the inclusion of parallel groups which received as stimuli the words which were the unique verbal labels for the pictures presented to the other groups. Thus, retention of pictures and of words signifying the same concepts could be tested. As was to be expected, pictures were retained better than words as measured by a recognition test. For both sets of stimuli, as presentation time increased, so did the mean number of correct responses. An interesting finding was that the positive slope for pictures as a function of presentation time was greater than the positive slope for words. The positive slope for words suggests that verbal rehearsal of these items was taking place during the presentation time. Lutz and Scheirer (1974) suggested that the greater positive slope for pictures lends support to Paivio's dual coding hypothesis which states that pictures have the advantage of both verbal and visual coding channels. The greater positive slope for pictures more specifically suggests the occurrence of both verbal and visual rehearsal during the presentation time.

The data presented by Lutz and Scheirer (1974) do not, however, support a concept of visual rehearsal which extends beyond the presentation time. As presentation time increased, retention of both words and pictures increased. However, retention increased at a faster rate for pictures than for words (greater positive slope for pictures). As the blank time increased, however, the slopes for pictures and for words were statistically equal. These slopes for pictures and for words as a function of the blank time were also equal to the slope for words as a function of presentation time. Thus it would appear that verbal rehearsal was taking place during both presentation time and blank time for both words and pictures. Visual rehearsal, however, seemed confined to the presentation time for pictures.

Clearly, Lutz and Scheirer (1974) succeeded in choosing stimuli which encouraged subjects to use a strategy of rehearsal both during presentation time and blank time. In addition, however, there is the possibility that these highly selected stimuli, chosen to be easily labeled by subjects, influenced the type of rehearsal strategy relied upon by the subjects. While it does not appear that visual rehearsal was the strategy used during the interstimulus intervals by the subjects in the Lutz and Scheirer (1974) study, this does not rule out the possibility that under more favorable conditions, visual rehearsal would occur during the intertrial interval.

In an effort to find conditions amenable to the occurrence of visual rehearsal, Weaver (1974) deliberately chose stimuli which would minimize the potential use of labels or other verbal encoding as a basis for recognition decisions. The stimuli consisted of eight categories of pictures, each containing a set of seven highly similar 35-mm color photographs. The categories included waves breaking on a beach, sunsets, and successive views of the same tree-lined boulevard. Of the seven photographs in each category, three pairs per category were selected which showed the highest degree of intrapair similarity. Selection of the pairs was initially done on the basis of judgments by Weaver with final selection determined by results from pilot data. From each pair, one photograph was chosen as the old item. The old items were used during presentation. The remaining photographs for each pair were designated as the new items and were used as distractor items on the recognition test. Adults were placed in one of four treatment conditions, each condition receiving only one of two presentation times (1 and 3 seconds) and one of two blank times (2 and 6 seconds). A very difficult two-alternative forced-choice recognition test followed the presentation sequence.

The Shaffer and Shiffrin (1972) study and the Lutz and Scheirer (1974) study both employed a simpler type of old/new decision procedure for testing picture recognition. This simpler procedure requires that the subject determine which test items are old (seen during presentation) and which are new (never seen before) as the items are presented one at a time during testing. No distractor items (new items) are consciously chosen for their confusability with the old items. The two-alternative forced-choice recognition test used by Weaver (1974) involved forcing the subject to determine for two carefully chosen, highly similar stimuli, which stimulus had been previously seen (old) and which had never been seen before (new). Subjects were given practice trials to familiarize them with the recognition task required of them. In this way, reliance on a verbal strategy was discouraged since a verbal code would be inefficient and inappropriate.

The Weaver (1974) results showed that both an increase in presentation time and an increase in blank time facilitated picture recognition. Weaver (1974) concluded that his results differ from those of Shaffer and Shiffrin (1972) for three possible reasons:

1. a different memory task was involved with the use of a very difficult forced-choice recognition test,

2. a different memory task was involved because of the highly similar stimuli used which made the

reliance on verbal strategies highly inefficient, and

3. an opportunity was provided for the adoption of a consistent processing strategy.

The results obtained by Weaver (1974) differ also from those of Lutz and Scheirer (1974). Whereas Weaver found beneficial effects for both blank time and presentation time, Lutz and Scheirer found such effects only for presentation time. Two possible reasons for this difference are:

1. the difficulty of the forced-choice recognition test, and

2. the deliberate attempt to render inefficient reliance on verbal strategies.

Weaver (1974) concluded that ". . . complexity of processing demands may determine whether poststimulus processing time (blank time) is an important determinant of subsequent recognition performance (p. 801)."

A study by Tversky and Sherman (1975) employed a number of experimental techniques designed to render blank time an important determinant of subsequent amount of retention. The absence of a blank time effect in the Shaffer and Shiffrin (1972) study puzzled Tversky and Sherman. They identified three aspects of the Shaffer and Shiffrin (1972) study which might account for their results. First, blank time was randomized in their within-subject design. Randomization, presumably, did nothing to encourage the use of an encoding strategy such as visual rehearsal. As a matter of fact, Tversky and Sherman (1975) suggested, randomization may have interfered with any efforts subjects may have made to discover efficient encoding strategies. Second, the recognition test used by Shaffer and Shiffrin (1972) may not have been sensitive enough to detect blank time difference. Performance was quite high in almost all conditions. Third, Tversky and Sherman (1975) suspected that visual rehearsal might have an effect on retention primarily on recall of pictures rather than on recognition of pictures, although they do not state what theoretical or experimental evidence led them to this suspicion.

Tversky and Sherman (1975) attempted to overcome these difficulties in the Shaffer and Shiffrin (1972) study and hoped, in their own study, to demonstrate the beneficial effects of blank time in picture memory. The stimuli used consisted of 60 slides of dictionary-type line drawings of familiar objects such as a fish, television, and bridge. The recognition test was a two-alternative forced-choice test for which the distractor items were highly similar dictionary-type line drawings of the same objects. A within-subjects blocked design was used for four presentation times (.25, .50, 1.00, and 2.00 seconds). Half the subjects received a blank time of 1.50 seconds. The other half received a blank time of 3.0 seconds. The subjects were only informed that a free recall test (in which they would verbally list what they had seen during the presentation) would follow presentation of the 60 pictures. All subjects received instructions that "their recall would be facilitated if they attempted to find categories or relationships among the items, and to use these groupings to organize the stimuli and guide their recall" (p. 116). The specific block structure of presentation time and blank time of the picture presentations was also explained to all subjects. Following a six-minute interval for free recall, the forced-choice recognition test was administered. Tversky and Sherman (1975) noted: "Previous research with half of these stimuli in a similar task had indicated that a prior test of free recall did not affect performance on a recognition task" (Tversky, 1973 cited in Tversky & Sherman, 1975).

The results of this study showed that blank time was positively related to picture retention as measured by both the free recall test and the forced-choice recognition test. The effect for presentation time was also significant for both recognition and recall. A very interesting result, made possible by the inclusion of two measures of retention was a virtual absence of a correlation between correct recognition and correct recall. The subjects appeared to be retrieving different information in response to each test. The increase in retention on the recall test as a function of blank time can be understood in terms of verbal rehearsal. The increase in retention on the recognition test as a function of blank time, however, cannot be easily attributed to verbal rehearsal. The correlational data would indicate that a separate, non-verbal storage-retrieval channel is being utilized in response to the heightened discrimination demands of the recognition test. Therefore, verbal rehearsal cannot explain the facilitative effect of blank time for both tests of retention. Tversky and Sherman (1975) concluded: ". . . increased blank time between pictures facilitated their recognition, indicating that rehearsal and/or encoding of the pictorial content of stimuli continued into the interstimulus interval" (p. 117).

Conclusions for Visual Rehearsal

In conclusion, it seems that under amenable conditions, people can be induced to use the imagery channel. It would appear from the few studies already done in this area that adults utilizing an imagery channel can be encouraged to benefit from increases in interstimulus intervals. Experimental techniques which have been successfully used to make the process of visual encoding, rehearsal, and retrieval more amenable to study are:

1. an incidental recognition test, and/or an extremely difficult recognition test to control verbal encoding in order to make more evident any visual rehearsal phenomenon,

2. an experimental design which includes blocked presentation times and variation between subjects for blank times in order to encourage the use of a consistent and efficient encoding strategy, and

3. instructional set, such as the instruction to categorize used by Tversky and Sherman (1975) to encourage the use of rehearsal strategies.

Weaver (1974) and Tversky and Sherman (1975) suggest that the benefits accrued from the increases in interstimulus intervals can be attributed to continued visual encoding which takes place throughout the interval. Tversky and Sherman (1975) concluded that "rehearsal and/or encoding" took place during blank time. Weaver (1974) was careful to point out that ". . . the data provide no insight into the nature of the process which might underlie the superior recognition performance found with longer interstimulus intervals" (p. 801). However, it seems clear that some type of continued visual encoding is taking place. Weaver (1974) wrote "To the extent that the use of photographs based on highly similar subject matter prevents or discourages efficient verbal encoding, the present results would suggest that visual memory is influenced by at least one of the variables (in this case, intertrial interval) known to be a determinant of retention for verbal material" (p. 801). Using Broadbent's (1958) expanded definition of rehearsal as further encoding during the absence of the physical stimulus, it would appear that visual rehearsal is a strategy available to and used by the subjects in these two experiments.

The question remains as to the precise nature of the visual encoding process taking place during the interstimulus interval. We can surmise from the studies thus far that verbal encoding is definitely the preferred mode for adults, even for pictorial content. For all studies so far reported in this section, the subjects were undergraduate or graduate students. Rather elaborate procedures (i.e., specially selected stimuli, an incidental and quite difficult recognition test, instructions, between-groups design) had to be used to encourage the use of nonverbal encoding processes. It would appear, then, that studying visual rehearsal in adults requires a high degree of experimenter structuring of the task. Perhaps a varied experimental approach would help to delineate the process and reveal its nature. One such approach which may prove useful is a developmental design.

A Developmental Approach

The developmental approach has met with some success as a method of studying verbal memory processes. John Flavell and his associates have employed this method of study for a number of years (Flavell, 1970, 1971; Flavell, Beach, & Chinsky, 1966; Flavell, Friedrichs, & Hoyt, 1970; and Kreutzer, Leonard, & Flavell, 1975). They have amassed a good deal of specific information which has clarified a number of aspects of verbal memory.

Flavell, Beach, and Chinsky (1966) have postulated that young children, although capable of memory strategies such as verbal rehearsal, will not use such strategies unless directed to do so. They call this phenomenon "production deficiency." In their study, ". . . there is a substantial increase in spontaneous verbal production from grade K to grade 2 . . . production continues to increase from grade 2 to grade 5, and this increase is likewise statistically significant . . ." (p. 292).

Belmont and Butterfield (1971), Flavell (1970), and Flavell, Friedrichs, and Hoyt (1970) have shown that as children mature, they become more efficient in using mediational strategies such as verbal rehearsal. Flavell, Friedrichs, and Hoyt (1970) found that, of the nursery, kindergarten, second and fourth graders studied, only the fourth graders showed a tendency to use a fairly complex, specific memory strategy. "The strategy appeared to consist of first naming the items (pictures) to oneself to initiate the learning process, and of subsequently using systematic anticipation and rehearsal procedures to monitor and maintain one's gradually increasing state of recall readiness" (p. 324). The "naming" phase of the strategy appears to be a developmentally earlier phase than are the phases of anticipation and rehearsal. Kingsley and Hagen (1969) demonstrated that nursery school children can be induced to use a rehearsal strategy which facilitates their recall performance.

Hagen and Kingsley (1968) found that vocalizing labels for pictures facilitated the memory performance of six- and eight-year-old children, although labeling did not affect the performance of four- and five-year-olds, nor that of ten-year-olds. A detrimental effect of labeling was found for college-age adults in one study by Hagen, Meacham, and Mesibov (1970).

In 1971, Flavell organized a symposium to discuss the question "What is Memory Development the Development of?"

(Flavell, 1971). Haith, a participant in this symposium, presented his and his associates' recent work. Haith (1971) argued that ". . . the encoding strategies which develop for visual memory are not necessarily verbal in nature" (p. 249). Haith discussed the work done by Sheingold (1971) and Morrison (1971) who tachistoscopically presented an array of eight familiar or geometric forms to children ages 5, 8, and 11, and adults. After presentation of the array, a teardrop shaped indicator was presented which pointed to one of the eight positions. The subjects' task was to name the item that had occupied that position.

Subjects of all ages seemed to rely on a fading trace or after-image of the array for up to about 100 msec. after the presentation of the stimulus. Performance at all age levels for up to 100 msec. post-presentation was remarkably similar. As a matter of fact, at 50 msec. post-presentation time, the 5-year-olds performed somewhat better than the adults. After 100 msec. up to 1,000 msec., the 5-year-olds dropped in accuracy at a faster rate than did the adults. From about 450 to 500 msec. on, the adults actually showed an upturn in their performance. It would appear that both children and adults process the array in a similar manner up until about 100 msec. into the blank time. After 500 msec. of blank time, the adults, but not the children, seem to be capable of further processing of the information. Haith (1971) wrote:

> We suspect that, after sequentially encoding the items, only adults visually rehearsed them. By visual rehearsal we mean something like rapid-fire imagery. We know little about this process. But adults sometimes reported that making eye movements over the vanished array helped to regenerate the information, a finding in keeping with Hebb's notion that imaginal activity can be facilitated by a 'reenactment' of eye movements (in this case movement that would have been engaged in had there been time) (Hebb, 1968). . . . Experience and familiarity must be important for these processes of brief storage, encoding and visual rehearsal. (p. 259)

In a recent study by Spitzer (1976), children in grades kindergarten, three, and six were either visually presented with 135 line drawings of common, easily labeled objects and animals or auditorially presented with the tape-recorded names of the same 135 objects and animals. Serial position learning was tested for the two modalities. The results showed that visual information was recalled better than auditory information, regardless of age. Also, primacy effects (superior retention of the first part of a presented list) are reported for picture recall by young children. Primacy effects are frequently used as evidence for rehearsal (Bernback, 1967; Hagen & Kingsley, 1968). However, the quality of the primacy effect observed by Spitzer (1976) seemed to differ for younger and older children. This may indicate that the quality of the rehearsal of items may also be different for the varying age groups. Upon close examination of the serial position data, Spitzer reported that:

> For older children, 'primacy' consisted of the first two or even three items, while for 5-year-olds, 'primacy' was only the first item. Thus, 5-year-olds appear to carry out some type of 'rehearsal' for the first item but it is apparently not the 'cumulative rehearsal' over several positions done by older children. (Hagen, Jongeward, and Kail, 1975 cited in Spitzer, 776-777)

The "rehearsal" suggested in the Spitzer (1976) study would seem to have elements of both verbal rehearsal (the picture stimuli were chosen so that they were "easily labelable") and visual rehearsal since, as in many previous studies, the visual modality yielded significantly superior recall.

Aside from this suggestion by Spitzer (1976) and the observation by Haith (1971) that "experience and familiarity" must contribute to the advantage held by adults, little has been said about the development of visual rehearsal. As Haith (1971) acknowledges, "We do not know how such strategies for visual encoding or for visual rehearsal might be taught [to children]" (p. 260). With appropriate procedures, it would appear feasible to teach a visual rehearsal strategy to children. Hagen (1971), speaking about verbal short-term memory, concluded that "young children who do not [verbally] rehearse spontaneously can be induced to do so. It is argued that, through experience, the child learns that his behavior determines how well he does. He is thus motivated to perfect his strategies and to develop new ones" (p. 262).

Development of Strategies to Improve Visual Memory

Levin and his associates have studied a number of strategies for improving children's memory on a pictorial discrimination task. The pictorial discrimination paradigm is identical to the more familiar verbal discrimination learning paradigm, except for the substitution of simple pictures in lieu of words for all members of the pairs. The procedure requires that two picture items at a time be presented to the subject for a period of time followed by a "feedback" interval during which the two items appear again in their same spatial positions but with the "correct" item now starred. After presentation of a number of these pairs, the subject is again presented with the unstarred pairs. During this second trial, the subjects indicate which item for each pair they think was previously starred. There is no effort made to make the items of the pairs similar in any way.

Levin, Ghatala, DeRose, Wilder, and Norton (1975) used this procedure while investigating imagery strategies in fifth and sixth grade students. In Experiment 1, the children were randomly assigned to one of three instructional conditions: a control condition in which the children were instructed to remember the correct item in each pair; the vocalization condition in which the children were instructed to pronounce the picture's label aloud three times during the feedback phase; and an imagery condition in which the children were instructed to form a visual image of the correct picture during the feedback phase. For the picture pairs (word pairs were also used in Experiment 1), the vocalization condition proved superior to both the imagery condition and the control condition. The imagery and control conditions did not differ significantly.

In Experiment 3 (Levin et al., 1975), the pictorial list of Experiment 1 was expanded and presented to sixth grade children. Again, three experimental conditions were used: control, vocalization, and, in this experiment, overt imagery which required the children to turn their heads to the side during the feedback phase and to trace the outline of the correct picture in the air in front of them while visualizing their constructed responses. The results showed that the performance of both the vocalization and overt imagery groups was nearly error-free, whereas the control group performance was significantly inferior.

While Levin et al. (1975) demonstrated that pictorial discrimination learning can be facilitated through appropriate rehearsal activities, three problems remain. The first problem is that if the facilitative effect of "imagery" rehearsal is limited to pictorial items which can be traced by children, the usefulness of a visual rehearsal strategy is greatly reduced.

Second, in both experiments, the pictorial items in the pairs presumably had different verbal labels. Thus, the pictorial discrimination task, as with the studies of visual rehearsal by Shaffer and Shiffrin (1972) and Lutz and Scheirer (1974), did not necessarily demand the use of a visual strategy. The preferred mode with these older elementary school children may be the verbal mode, as seems to be the case for adults.

The third problem is the reported ceiling effect in Experiment 3. Any possible differences in the effectiveness of the overt imagery strategy and the vocalization strategy were not able to be demonstrated because of the relative ease with which the task was performed by the subjects. It remained to be seen whether pure visual memory can be enhanced by the use of a visual rehearsal strategy.

Contradictory evidence has been reported on the effect of age on picture recognition memory. Brown (1973) and Nelson (1971) reported the absence of apparent age trends in recognition memory for pictures. However, Tversky and

Teiffer (1976), using the difficult two-alternative, forced-choice recognition test previously used by Tversky (Tversky, 1973; Tversky & Sherman, 1975), found that there was a significant improvement in recognition performance from ages 5 to 12 years. Tversky and Teiffer (1976) presented elementary school children with a series of 30 slides of line drawings of familiar objects. Two instructional sets were used: a recall set which emphasized semantic organization of the pictures and prepared the subjects for a recall test, and a recognition set which emphasized a strategy of paying careful attention to the details of the pictures and prepared the subjects for a recognition test. The results showed a significant main effect for age for both the recall test and the recognition test, but a main effect for instruction only for the recall test where recall instructions were increasingly effective with age. Since Tversky (1973) had previously found that college students' recognition scores were improved significantly by the recognition strategy, Tversky and Teiffer (1976) felt that it was of a priori interest to examine the oldest age group for possible instructional effects on the recognition test even though no main effect for instruction was found. The expectation of an effect for instruction at the oldest age level was confirmed. The oldest recognition-set children performed significantly better on the recognition test than did the recall-set children.

It would appear, then, that when the recognition test is sensitive enough to eliminate the possibility of a ceiling effect, the development of picture recognition can be demonstrated. It also appears that picture recognition is sensitive to strategies, since 12-year-olds supplied with a strategy for discrimination outperformed those supplied with a strategy for recall.

Chapter III

Questions and the Hypotheses

The study presented here addressed a number of sets of questions about visual and verbal rehearsal strategies for pictures. The basic design used is a 3 x 4 x 4 repeated measures design with three levels of instructional conditions (verbal, visual, and control), four levels of grades (kindergarten, three, six, and college), and four levels of blank time (1, 3, 6, and 9 seconds). Blank time was the repeated measure. Two dependent measures were included, a recall test and a recognition test.

Question Set I

The first set of questions concerned determining the presence of visual rehearsal. Is there a process of visual rehearsal of visually encoded material? Do increases in the interstimulus interval result in increases in retention of the visually presented material? Is the process of visual rehearsal similar in children and adults? These questions have basic theoretical significance for psychology and memory research. The two studies to date which have concluded that visual rehearsal of complex visual stimuli is a process engaged in by adults (Weaver, 1974; Tversky & Sherman, 1975) share a basic problem. They have extremely limited generalizability. A highly specified, structured setting had to be established, including carefully selected stimuli and well-educated adults, in order to demonstrate a blank time effect for recognition.

Question Set I also concerned the possibility of a developmental contribution to the production of visual rehearsal. Flavell, Friedrichs, and Hoyt (1970) have demonstrated that children younger than fourth grade do not spontaneously use a complex strategy to remember which includes verbal rehearsal. It would seem probable that there is also a developmental effect for the process of visual rehearsal. This aspect of the first question has direct applicability to a theory of the development of memory processes. As noted during Flavell's (1971) symposium on memory development, visual memory processes in children are almost totally unexplored. The present study was designed to collect data which would permit comparisons with Flavell's and others' data on the development of verbal memory strategies in children.

A first general hypothesis can be advanced for Question Set I: College and sixth grade groups which are given more time to rehearse spontaneously will show more visual memory than these groups will show when they are not given as much time to rehearse. The Experimental Hypotheses are:

1. The college control group will show greater recall at the 3, 6, and 9 second blank time intervals than at the 1 second blank time interval.

2. The sixth grade control group will show greater recall at the 3, 6, and 9 second blank time intervals than at the 1 second blank time interval.

3. The college control group will show greater recognition at the 3, 6, and 9 second blank time intervals than at the 1 second blank time interval.

4. The sixth grade control group will show greater recognition at the 3, 6, and 9 second blank time intervals than at the 1 second blank time interval.

A second hypothesis can be advanced for Question Set I: Kindergarten and third grade groups which are given more time to rehearse spontaneously will not show more visual memory than these groups show when they are not given as much time to rehearse. The Experimental Hypotheses are:

1. The kindergarten control group will show no greater recall at the 3, 6, and 9 second blank time intervals than at the 1 second blank time interval.

2. The third grade control group will show no greater recall at the 3, 6, and 9 second blank time intervals than at the 1 second blank time interval.

3. The kindergarten control group will show no greater recognition at the 3, 6, and 9 second blank time intervals than at the 1 second blank time interval.

4. The third grade control group will show no greater recognition at the 3, 6, and 9 second blank time intervals than at the 1 second blank time interval.

Question Set II

These questions concerned the problem of the precise nature or form of visual rehearsal and the effect of a subject's age on its form. Visual rehearsal was inferred from the blank time effect on retention found by Weaver (1974) and Tversky and Sherman (1975). Little is known about the limiting characteristics of the processes occurring during blank time which presumably affect picture retention. Studies thus far answer few questions about the process aside from the possibility that continued encoding is taking place. This lack of knowledge is extensive with respect to the process within children.

Direct comparisons of visual rehearsal with verbal rehearsal were possible in the present study. Tversky and Sherman (1975) showed that at a presentation time of

2 seconds for adults (which was used for all persons in this study), the percentage of recall is approximately 50% at 1.5 seconds blank time and approximately 55% at 3.0 seconds blank time. For recognition, they reported percentage rates of approximately 80% (again at the presentation rate of 2 seconds for adults) at 1.5 seconds blank time and approximately 90% at 3.0 seconds blank time. Tversky and Sherman (1975) used only these two blank times so we get no sense of the shape of the function for the blank time effect which they report.

Weaver (1974) also used two blank times, 2 seconds and 6 seconds. The presentation times were 1 second and 3 seconds. Weaver (1974) wrote:

> The magnitude of the improvement in recognition under the 6-sec. relative to the 2-sec. interstimulus interval was approximately the same under both levels of stimulus duration and the interaction of these two variables resulted in $F < 1$. (p. 800)

The amount of blank and presentation times, while significantly affecting the quantity of retention, do not seem to qualitatively affect the process. It would appear from these data that we are coming in in the middle of an on-going process. Again as in Tversky and Sherman (1975), we do not see evidence of a delay time necessary for the process to "kick in" nor evidence of an asymptote or leveling-off of the effect.

This second question has direct relevance for a theory of memory which includes non-verbal memory, such as Paivio's dual coding model. Much specific information has been filled in for the verbal channel of Paivio's model, but only vague suggestions can be offered so far for the non-verbal channel.

The second question is also of interest to school learning theorists and practitioners. The development of both curricula and materials must be accomplished on the basis of sound information about the capabilities and preferences of children at differing levels of development. Bruner's (1964) theory of representation would predict that children of elementary school age would utilize primarily an icon (image) mode of representation. A recent study by Spitzer (1976) suggested that the visual format includes an element which cannot be reduced to verbal representation, thus facilitating retention. Spitzer (1976) concluded:

> . . . the present findings indicate that young children derive benefit from visual materials--more so, in fact, than from auditory materials--and that this visual advantage remains constant throughout the elementary years. (p. 772)

Given the evidence supporting the power of the visual mode of presentation for children's learning, including studies evaluating Educational Television's Sesame Street (Warren, 1976), it is incumbent upon educators to fully understand the role and capabilities of visual memory in children's learning at various age levels.

A first general hypothesis can be advanced for Question Set II: College and sixth grade groups which are given the opportunity to rehearse will show increased retention with increases in the blank time intervals as measured by both retention tests. The Experimental Hypotheses are:

1. For the college control group, there will be a linear trend for recall of visual stimuli on the basis of increases in blank time.

2. For the sixth grade control group, there will be a linear trend for recall of visual stimuli on the basis of increases in blank time.

3. For the college control group, there will be a linear trend for recognition of visual stimuli on the basis of increases in blank time.

4. For the sixth grade control group, there will be a linear trend for recognition of visual stimuli on the basis of increases in blank time.

A second general hypothesis can be advanced for Question Set II: Kindergarten and third grade groups which are given the opportunity to spontaneously rehearse will show no increased retention with increases in the blank time intervals as measured by both retention tests. The Experimental Hypotheses are:

1. For the kindergarten control group, there will be no linear trend for recall of visual stimuli on the basis of increases in blank time.

2. For the third grade control group, there will be no linear trend for recall of visual stimuli on the basis of increases in blank time.

3. For the kindergarten control group, there will be no linear trend for recognition of visual stimuli on the basis of increases in blank time.

4. For the third grade control group, there will be no linear trend for recognition of visual stimuli on the basis of increases in blank time.

Question Set III

The third set of questions addressed in this research asked "To what extent are instructional sets capable of affecting any developmental differences in coding capability?" How responsive to instructions are visual codes? At what age are children able to differentially encode the same stimulus when given instructions to do so? Do instructional sets have a differential effect on types of retention tests? Will there be a facilitative effect for subjects when a "match" exists between input or storage mode and retrieval cues or retention test form?

Kingsley and Hagen (1969) have shown that nursery-school children can be induced to use verbal rehearsal to facilitate their recall performance. Hagen and Kingsley (1968) demonstrated that instructing children to vocalize labels for pictures increased the recall performance of six- and eight-year olds.

Tversky and Teiffer (1976) reported increased recall for children in grades kindergarten, three, and five as a result of training and instructions to use a recall strategy which involved identifying similarities, relations, and semantic associations among items. Tversky and Teiffer (1976) also reported a failure to find a main effect for instruction on a two-alternative forced-choice recognition test. However, an a priori test showed that the oldest age group performed better on the recognition test when they were trained and instructed to use a strategy which emphasized attention to visual details as compared with the group trained and instructed to use the recall strategy.

Levin, and his associates (Levin Ghatala, DeRose, Wilder, & Norton, 1975) reported that a sixth grade group which received vocalization instructions (instructions to say the picture's label three times during an interstimulus interval) performed better in a picture discrimination learning task than did a sixth grade control group. Also in this study, Levin et al. demonstrated that instructions to form a visual image of the correct picture for each pair presented did not produce better retention than no instructions (control group). The picture discrimination learning task, however, can be successfully handled using labels alone. Each picture for the pairs of pairs of pictures presented has a unique label. Verbal encoding alone could suffice. The discrimination learning task as set up by Levin et al. (1975) does not require detailed visual discrimination.

Using a similar task, Levin, Ghatala, DeRose, and Makoid (1977) introduced an Image-Trace instruction in which the subject is told to note the designated item in the pair, then imagine the picture, and finally, to turn away from the stimulus and to trace the outline of the picture in the air with his finger. The Image-Trace instruction improved the discrimination learning performance of fifth graders over that of the control group and the Trace (i.e., on top of the stimulus rather than from an image) group. The control group and the Trace group did not differ significantly in performance.

Instructions to label pictures and to rehearse these labels were expected, in the present study, to increase the retention scores for third grade children, and perhaps the kindergarten children too. The hypothesis was that instructions to visualize and rehearse images would also increase the retention scores for this age range on a test which required reliance on a visual code.

Question Set III has major significance for school learning and instruction. Most of the work done so far in the training of metamemory and memory strategies in children has been done in the area of verbal learning or learning based on verbal encoding. Some studies have been done, however, in the training of children in the use of imagery as a mediational aid to prose learning. Levin (1973) has found that internal imagery facilitates prose learning when one sentence is presented at a time. Lesgold, McCormick, and Golinkoff (1975) reported that children in the third and fourth grades performed better on a paraphrase recall task for a prose passage when explicit imagery instructions were given with the task. The improved recall, however, was dependent upon prior extensive training in drawing adequate "comic strips" to illustrate prose passages.

These studies concentrated on the facilitative effect of imagery on verbal learning. The underlying assumption seems to be that the images which are used as an aid to verbal memory will be self-sustained or ever-present in the child. The retention test for the Lesgold, McCormick, and Golinkoff (1975) study immediately followed the presentation phase. The facilitative value of these images may not survive for much longer periods of time. Sustaining detailed images over longer periods of time, whether these images are formed from direct perception or as a totally reconstructive exercise in response to a verbal stimulus, may require cognitive activity such as visual rehearsal to transfer the images to long-term memory. It may not be a matter of training children in the mechanism of visual rehearsal so much as instructing the children in how to bring the strategy under their conscious control and when it is appropriate and efficient to use the strategy.

Both Bruner (Bruner, Olver, & Greenfield, 1966) and Piaget (Piaget & Inhelder, 1971) have suggested that young children rely on imagery as a memory format. These images of retained information appear to influence the behavior of even very young infants. DeLoache (1976) wrote, referring to habituation in young infants:

> The decline in attention (habituation to a stimulus pattern) is generally thought to reflect the acquisition of an internal representation or memory model of the stimulus (Cohen, 1973; Lewis, 1967; McCall, 1971; Sokolov, 1963). Presumably, the subject compares each incoming stimulus to his memory model of past stimuli. (p. 145)

It would appear then that the process involved here is one of repetition in order to build up a viable, durable image. This same process of repetition, internalized, may also be necessary in later life in order to develop a durable image of some complexity.

The final question also investigated whether there is an interaction between the input mode used by the subjects and their scores on the two dependent measures of retention to be used. Those subjects instructed to encode and rehearse a visual image may have enhanced recognition test scores compared to both the control group (no instructions) and the verbal instruction group. The visual instruction group, however, may not display an increment on the free recall test of retention (verbal) when compared to the control group. On the other hand, the group instructed to encode and rehearse a verbal label for each picture may show a facilitative effect of this mode of encoding on the free recall test, but no such advantage on the recognition test (visual discrimination).

Arthur and Daniel (1973) found that college students took more time to correctly respond to a recognition test when the items were presented in a cross-mode format (verbal presentation, visual test and, also, vice versa). The transfer between verbal and visual memory modes seems to require additional processing time.

Tulving and Thomson (1973) have postulated a principle of encoding specificity which suggests that a retrieval cue elicits information stored in memory only to the degree to which its informational content matches the informational content of the memory trace. The encoding specificity principle as proposed by Tulving and Thomson (1973) is: "the memory trace of an event and hence the properties of effective retrieval cue are determined by the specific encoding operations performed by the system on the input stimuli" (p. 352).

Bormuth (1970) also suggested that a "match" must exist between input and retrieval. He stated that the very sentence structure of verbal information will affect the memory content. In order for a verbal retention test to be valid, a match in syntactic and semantic structure must exist between the presented information (i.e., the instruction) and the retention test.

Tversky and Sherman (1975), using both a recognition test and a recall test to measure retention of both visual and verbal information, reported that there was virtually no correlation between correct recognition and correct recall within each subject. They suggest that the subjects were retrieving different information in response to each test.

Certainly educators must make efforts to see that their measures of retention bear a direct relationship to the instruction they provide their students. Given the emphasis today on multi-media presentations of information and instruction, it is essential and relevant to test the relationship between these various modes of presentation and the various types of retention tests. Add to this the possibility of individual differences in preference and capability within a mode, and it is clear that educators and test constructors must have experimental evidence on the question of presentation mode/test mode matching.

The first general hypothesis under Question Set III is that visual rehearsal instructions will result in increased retention for the kindergarten and third grade groups on the recognition test. The Experimental Hypotheses are:

1. Kindergartners in a visual rehearsal instruction group will show greater recognition than those kindergartners in a control group.

2. Third graders in a visual rehearsal instruction group will show greater recognition than those third graders in a control group.

3. Kindergartners in a visual rehearsal instruction group will show no greater recall than those kindergartners in a control group.

4. Third graders in a visual rehearsal instruction group will show no greater recall than those third graders in a control group.

5. College students in a visual rehearsal instruction group will show no greater recognition than those college students in a control group.

6. Sixth graders in a visual rehearsal instruction group will show no greater recognition than those sixth graders in a control group.

The second general hypothesis under Question Set III is that verbal rehearsal instructions will result in increased retention for the kindergarten and third grade groups on the recall test, but not on the recognition test. The Experimental Hypotheses are:

1. Kindergartners in a verbal rehearsal instruction group will show greater recall than those kindergartners in a control group.

2. Third graders in a verbal rehearsal instruction group will show greater recall than those third graders in a control group.

3. Kindergartners in a verbal rehearsal instruction group will show no greater recognition than those

kindergartners in a control group.

4. Third graders in a verbal rehearsal instruction group will show no greater recognition than those third graders in a control group.

5. College students in a verbal rehearsal instruction group will show no greater recall than those college students in a control group.

6. Sixth graders in a verbal rehearsal instruction group will show no greater recall than those sixth graders in a control group.

Chapter IV

Method

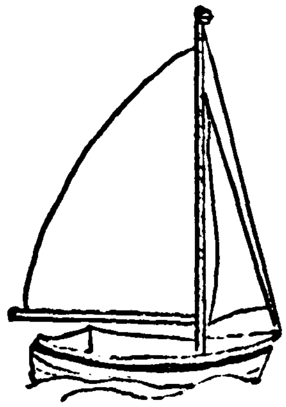
Subjects

The subjects were 36 students for each of grades kindergarten, three, six, and college. The 36 children in kindergarten had a mean chronological age (CA) of 5 years 6 months, ranging from 5 years 0 months to 5 years 11 months. The 36 children in third grade had a mean CA of 8 years 4 months, ranging from 7 years 10 months to 8 years 10 months. The 36 children in the sixth grade had a mean CA of 11 years 3 months, ranging from 10 years 9 months to 11 years 11 months. Six females and six males from each grade group were randomly assigned to each of the three treatment groups. The total number of subjects was 144.

The elementary school subjects were drawn from a predominately white, upper middle-class community which has a small percentage of black, Hispanic, and Asian students. The college students were volunteers from a large city university located near the participating elementary schools. Most of the college students were white and middle-class.

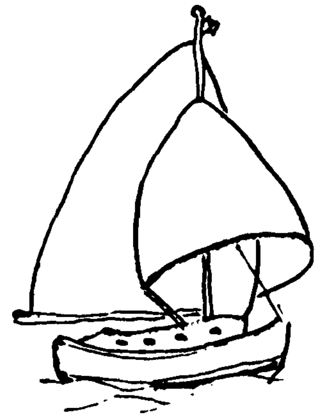
<u>Materials</u>

The materials used were those developed by Tversky and Sherman and first used by them in their 1975 study. The stimuli consisted of 60 black and white sketches of familiar objects and animals. A list of the 60 stimuli along with synonyms used by the subjects appears in Appendix A. Two of the pictures, along with their labels and acceptable synonyms, appear in Figure 1. These pictures were projected as slides on a standard portable white screen 46" x 46" by a Kodak Carousel projector with a Lafayette tachistoscopic shutter attached in order to control presentation time. The blank times were controlled by a Hunter timing device. During the blank times, the shutter was closed and the screen was dark. Each subject was tested individually in a private, darkened room within his/her school. The subjects sat in a chair positioned 5' in front of the screen and slightly to the right. The projectors and other equipment were on a long table 9' in front of the screen. The experimenter sat behind the equipment table during presentation and the recognition test. During the recall test, the experimenter brought a chair over and sat facing the subject.

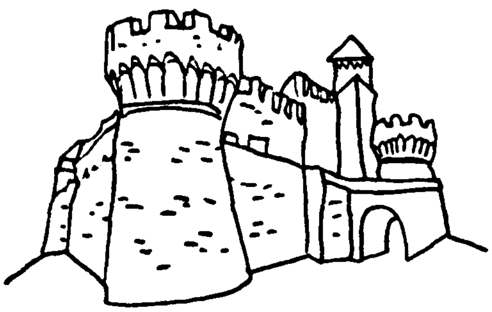


Label: sailboat

Synonym: boat

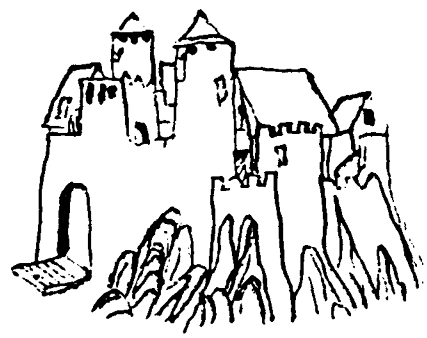


Distractor: sailboat



Label: castle

Synonyms: kingdom; sandcastle



Distractor: castle

Figure 1. Examples of stimulus pictures and distractor pictures, with labels and synonyms used by verbal subjects during presentation.

Design

The data were analyzed using a 3 x 4 x 4 repeated measures factorial design with three levels of instructional set (verbal, visual, and control), four levels of grades (kindergarten, third, sixth, and college), and four levels of blank time (1, 3, 6, and 9 seconds), which were repeated across subjects. Blocked trials for these blank times, in which all stimuli in the blocked trial are followed by the same blank time, appears from previous research (Weaver, 1974; Tversky & Sherman, 1975) to be necessary in order to encourage the use of consistent encoding strategies. The range of 1 second to 9 seconds was chosen so that possible "warming up" or "leveling off" effects could be observed. Neither effect was evident in the Tversky and Sherman (1975) data where the blank times were 1.5 and 3.0 seconds, nor in the Weaver (1974) data where the blank times were 2.0 and 6.0 seconds.

Blank time was a repeated measure with order of presentation of blocked times varied for each subject within a cell of the design. Each of the four blank time blocks consisted of 15 pictures for a total of 60 pictures. The four blank times can be ordered in 24 possible sequences. Of these 24 sequences, 12 were randomly chosen. Each of these 12 sequences was used once for each of the 12 subjects in each cell of the experiment. The sequences can be found in Appendix B.

One order of presentation of the pictures was used. The same order was used for the recognition test. All subjects received a presentation time of 2 seconds per picture. This allowed adequate time for the subjects to complete initial processing (including perception and recognition itself). Broadbent (1958, 1963) noted that a sensory store can hold information without analysis for up to 1 second or so. Also, Mackworth (1959) noted that a verbal encoding takes up to 1 second to become established.

Between-Groups Variables

There were two between-groups variables. The first was grade. Four grades were used, with 36 subjects per grade. The grades were kindergarten, third, sixth, and college.

The second between-groups independent variable was instructional set, the encoding factor. The three instructional groups were: a label and verbal rehearsal set (verbal), an image formation and rehearsal set (visual), and a control group which received no instructional set (control). The verbal group was instructed to verbally label (out loud) the pictures at presentation and to rehearse these labels subvocally during the time between pictures. The visual group was instructed to form a detailed picture in their minds for each picture and to rehearse these internal images during the time between pictures. The control group received no suggestion whatsoever with regard to encoding strategies. The introductory instructions (given to all subjects) were:

> We are going to play a game dealing with remembering pictures. I am going to show you on this screen in front of you, pictures of familiar objects . . . things you'll recognize when you see them. You just sit and watch the pictures. The aim of the game is to try and remember as many of the pictures as you can.

The following additional introductory instructions were given to the verbal group:

> It will be easier to succeed in the game if you say aloud the name of the object you see. Say the name aloud of every picture as you see it. You will have some time in between pictures to repeat in your mind many of the names. Repeat lots of the names over and over so you will remember them. Just as you would if you were trying to remember someone's telephone number . . . you'd say it over and over to yourself so you wouldn't forget it. Do the same

thing here . . . say the names over and over so you remember them. Try to remember as many of the pictures as you can.

The following additional introductory instructions were given to the visual group:

It will be easier to succeed in the game if you make a picture in your mind of each picture you see on the screen. Just look at the picture on the screen, then make the same picture in your mind. Like you would do if I asked you about your living room at home . . . you can picture your living room in your mind, where the sofa is, what color it is . . . do the same thing with the pictures. Imagine the pictures in your mind. You will have time in between the pictures to imagine many of the pictures. Repeat lots of the pictures in your mind over and over again so you will remember them. Try to remember as many of the pictures as you can.

The final instructions, which were given to all the subjects, were:

Now, I will show three practice pictures so you'll see how to play the game. You try to remember them. Ready?

The following additional final instructions were given to the control group:

Do you remember the pictures you just saw? Okay. Let's play the game. Ready?

The following additional final instructions were given to the verbal group:

(While showing three practice pictures, remind subjects to say the names of each object aloud as they see it.) Do you remember the pictures you just saw? Did you say the names over and over again to yourself? Okay. Let's play the game. Ready?

The following additional final instructions were given to the visual group:

(While showing three pictures, remind subjects to imagine each picture as they see it; then to repeat the images.) Do you remember the pictures you just saw? Did you make a picture in your mind of each of the pictures? Did you repeat the pictures you made in your mind over and over again? Okay. Let's play the game. Ready?

Dependent Measures of Retention

Immediately following the presentation of the 60 pictures, all subjects were given two dependent measures of retention, a free recall test and a two-alternative forced-choice recognition test. Previous research using half of these 60 stimuli on a similar task had shown that performance on a recognition task is not affected by a prior test of free recall (Tversky, 1973). Immediately following presentation, the subjects were asked to freely recall as many of the pictures they had just seen as they could. The free recall test lasted six minutes. Each subject's free recall test responses were recorded by the experimenter. The free recall test was scored for number of correct responses based on the judgement of two judges. The labels vocalized during presentation by the verbal group helped in these judgments of close synonyms.

Immediately following the recall test, the second dependent measure was given. This test of retention was a two-alternative forced-choice recognition test using pairs of stimuli, one of which was the original picture and the other a distractor, a highly similar picture of the same concept. Each pair of pictures was presented for four seconds. The subjects were instructed to point with a 3' long bamboo stick to the picture that had appeared during presentation. The stimulus on the right side of the screen for each pair was the correct response for a random half of the test trials. Similarly, the left stimulus of each pair was the correct response for the remaining half of the test trials.

Retention test instructions were given to all the subjects immediately following presentation of the 60 pictures.

The free recall test instructions, given to all subjects, were:

> Good. You just saw a lot of pictures. Can you remember some of the pictures you saw? Which ones do you remember? . . . Is there anything else you remember?

The recognition test instructions, given to all subjects, were:

> I have another way to remember pictures. I'll project onto the screen two pictures at the same time. One of the pictures will be the one you saw before. This will be the "old" picture. The other picture will be the same object, but it will be drawn a little differently. Every time you see two pictures, you decide which one of them is the "old" picture, the one you saw before, then point to it with this pointer. Sometimes the "old" picture will be on the left, sometimes the "old" picture will be on the right (pointing with pointer to demonstrate). So look carefully. Remember to point to the "old" picture, the one you saw before. Here we go.

Chapter V

Results

Scoring

Two total scores were recorded for each subject. The recall test total score was the total number of pictures that the subject correctly named in the six-minute free recall test period. A correct name was either the designated label, a synonym for the label which was used by a subject in the verbal group during presentation, or a synonym for the label which two judges deemed an acceptable synonym.

Four recall subscores were also recorded for each subject. These subscores were the total number of correctly recalled pictures for each of the four blocked trials of 15 slides. Thus, the subscores indicated the recall subtotals per block, with a maximum possible score of 15 per block. The total recall score was the grand total recalled from all four blocks, with the maximum score being 60.

The recognition test total score was the total number of pictures that the subject, during the recognition test period, correctly designated as being previously seen. Each picture was presented along with a distractor which was a picture which was highly similar to the "old" picture.

Four recognition subscores were also recorded for each subject. These subscores were the total number of correctly identified pictures for each of the four blocked trials of 15 slides. Thus, the subscores indicated the recognition subtotals per block, with a maximum possible score of 15 per block. The total recognition score was the grand total recognized from all four blocks, with the maximum score being 60.

During the data collection, it was noticed that a few subjects in the verbal group were using the label "boat" for either the "sailboat" or the "battleship," or both. The "sailboat" occurred in the third quarter of the presentation sequence and the "battleship" occurred in the fourth quarter of the presentation sequence. This same problem occurred, to a lesser degree, with the label "bike" or "bicycle" used for either "tricycle" or "bicycle," or both. The "tricycle" appeared in the first quarter of the presentation sequence and the "bicycle" appeared in the second quarter of the presentation sequence. Since the pictures occurred in different blank time blocks, the free recall protocols for all 144 subjects were subsequently examined to see how these synonyms affected scoring on the free recall test. Of the 144 subjects, 15 responded with only one "boat" on the free recall test. Nine of the 144 subjects responded with only one "bicycle" or "bike." Analyses of variance were performed for recall twice; once with the free recall response "boat" scored as "sailboat" and once with the free recall response "boat" scored as "battleship." If there were not relevant differences in the analyses as a result of the 15 subjects whose "boat" responses were arbitrarily assigned to one block or another, then it was felt that the analyses would also not differ if the nine responses of "bicycle" or "bike" were arbitrarily credited with a correct response for "bicycle."

The analyses of variance results when scoring "boat" as "sailboat" or when scoring "boat" as "battleship" were virtually identical, as can be seen in Table 1. Thus, the following results are reported using the arbitrary decision to accept a free recall response of "boat" as "sailboat" and "bicycle" or "bike" as "bicycle."

Overall Analyses

Means and standard deviations for number correct per blank time block on the recall test for each grade and group are shown in Table 2. The means and standard deviations for the number correct per blank time block on the recognition test for each grade and group are shown in

Table 1

Comparison of Analyses of Variance for Two Interpretations of "Boat" Response on the Free Recall Test

	Scoring of "Boat"			
	As "Sailboat"		As "Battleship"	
Main Effects	*F*	*p*<	*F*	*p*<
Grade	12.76	.01	12.58	.01
Group	3.20	.05	3.26	.05
Block	8.48	.01	8.99	.01

Table 2

Mean Number Correct Per Block and Standard Deviation on Recall Test for Each Group

	Instructional Condition					
	Verbal		Control		Visual	
Grade Group (N)	M	SD	M	SD	M	SD
Kindergarten (12)	2.65	.96	2.77	.84	2.77	1.17
Third (12)	4.46	.87	3.46	.85	3.60	.75
Sixth (12)	5.79	.60	5.06	.94	4.98	1.31
College (12)	7.65	1.01	7.42	1.37	7.27	1.31

Table 3.

Separate analyses of variance were performed on each of the dependent variables, recall and recognition, with grade, instructional group, and blank time (the repeated measure) as factors. The total number correct for recall as a function of blank time and instructions is presented in Figure 2. For all three instructional groups, the total number of pictures recalled increased as the interstimulus interval (blank time) increased. The effect of blank time for the recall test was significant, $\underline{F}$ (3, 360) = 8.50, $\underline{p} < .01$. This result is consistent with previous research (Tversky & Sherman, 1975).

This blank time effect for the recall test showed a significant linear trend, $\underline{F}$ (1, 360) = 21.74, $\underline{p} < .01$, from 1 second to 9 seconds.

The effect of instruction was significant for recall, $\underline{F}$ (2, 120) = 3.20, $\underline{p} < .05$. This result is consistent with the results obtained by Tversky and Teiffer (1976). In the present study, the verbal instructional group was superior to both the control group and the visual group (which did not differ significantly from each other) at all four blank times.

The total number correct for recall as a function of blank time and grade is presented in Figure 3. A very clear pattern of the strong age effect on recall can

Table 3

Mean Number Correct Per Block and Standard Deviation on Recognition Test for Each Group

	Instructional Condition					
	Verbal		Control		Visual	
Grade Group (N)	M	SD	M	SD	M	SD
Kindergarten (12)	12.13	1.15	11.40	1.87	11.06	1.72
Third (12)	13.29	.57	12.06	1.12	11.56	1.49
Sixth (12)	13.15	1.04	12.13	1.59	11.15	2.07
College (12)	13.44	.67	12.31	1.54	12.21	1.35

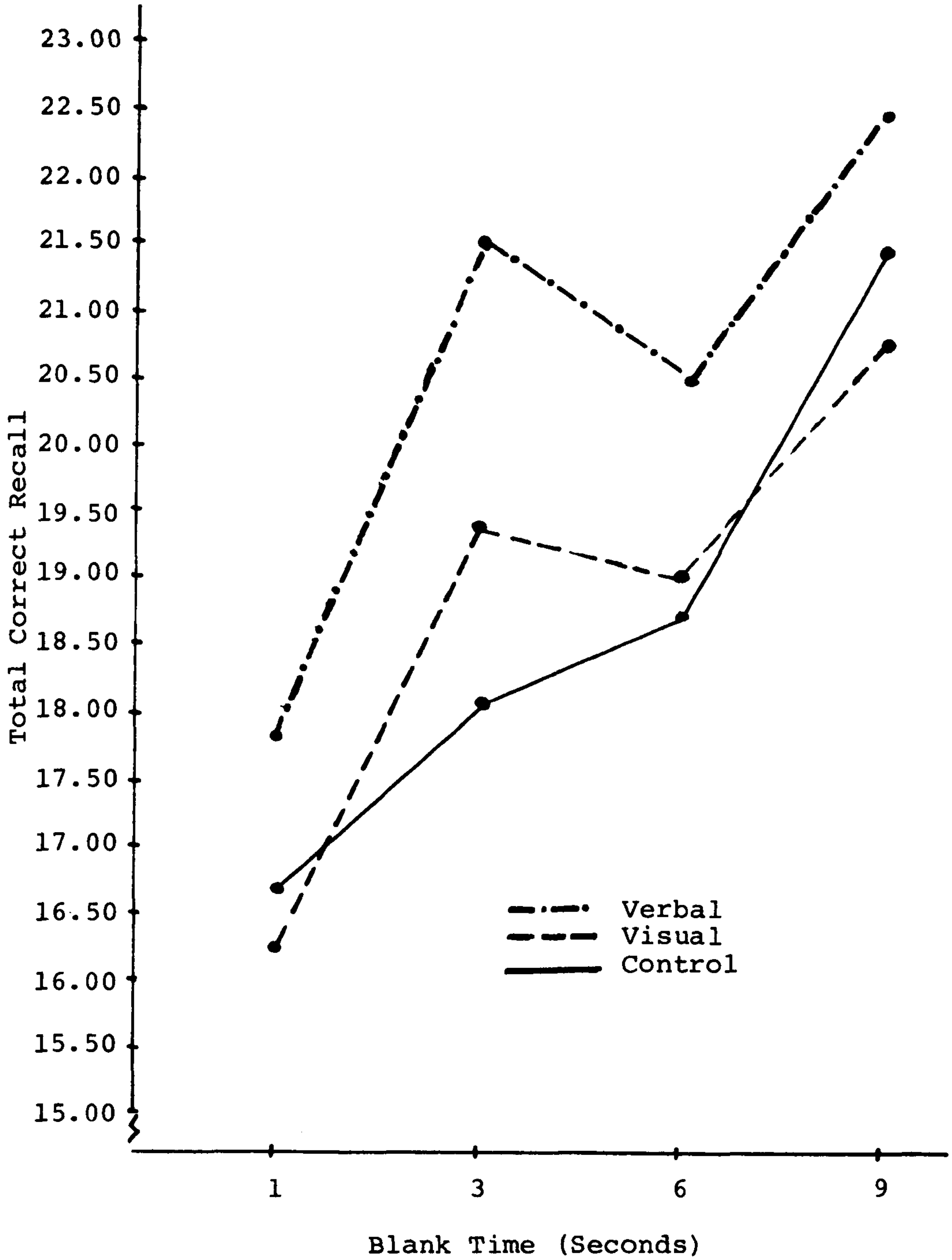


Figure 2. Total correct recall as a function of blank time and instructions.

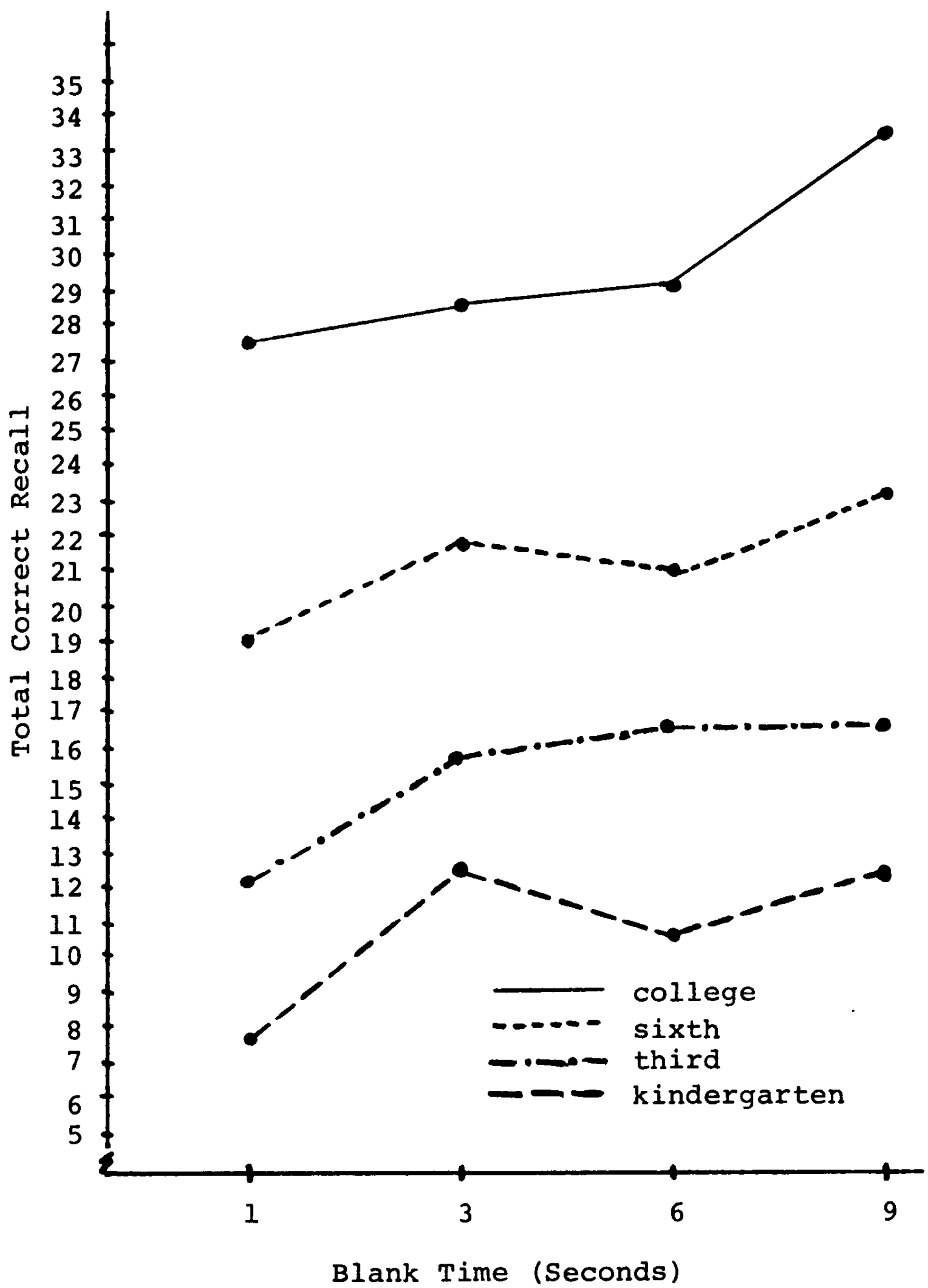


Figure 3. Total correct recall as a function of blank time and grade.

be seen. The effect of grade was significant for recall, F (3, 120) = 135.37, $p < .01$. This result conforms with the results found by Tversky and Teiffer (1976), who used subjects in grades kindergarten, three, and five.

The total number correct for recognition as a function of blank time and instructions is presented in Figure 4. While the control and visual instructional groups showed a very slight gain in recognition as a function of an increase in blank time from 1 to 9 seconds, the verbal group showed a very slight decline in total recognition as a function of blank time. The overall effect of blank time for the recognition test was not significant. This result is in conflict with the results obtained by Tversky and Sherman (1975). However, their study was limited to adults and a direct comparison will be made later when the age groups are examined separately.

The effect of instruction on recognition was significant, F (2, 120) = 13.20, $p < .01$. The verbal group outperformed both the visual and the control groups at each of the four blank times. This result is in contrast to Tversky and Teiffer (1976), who failed to find an overall effect for instruction using a similar task. The results are consistent, however, with Levin, Ghatala, DeRose, Wilder, and Norton (1975), who found an instruction

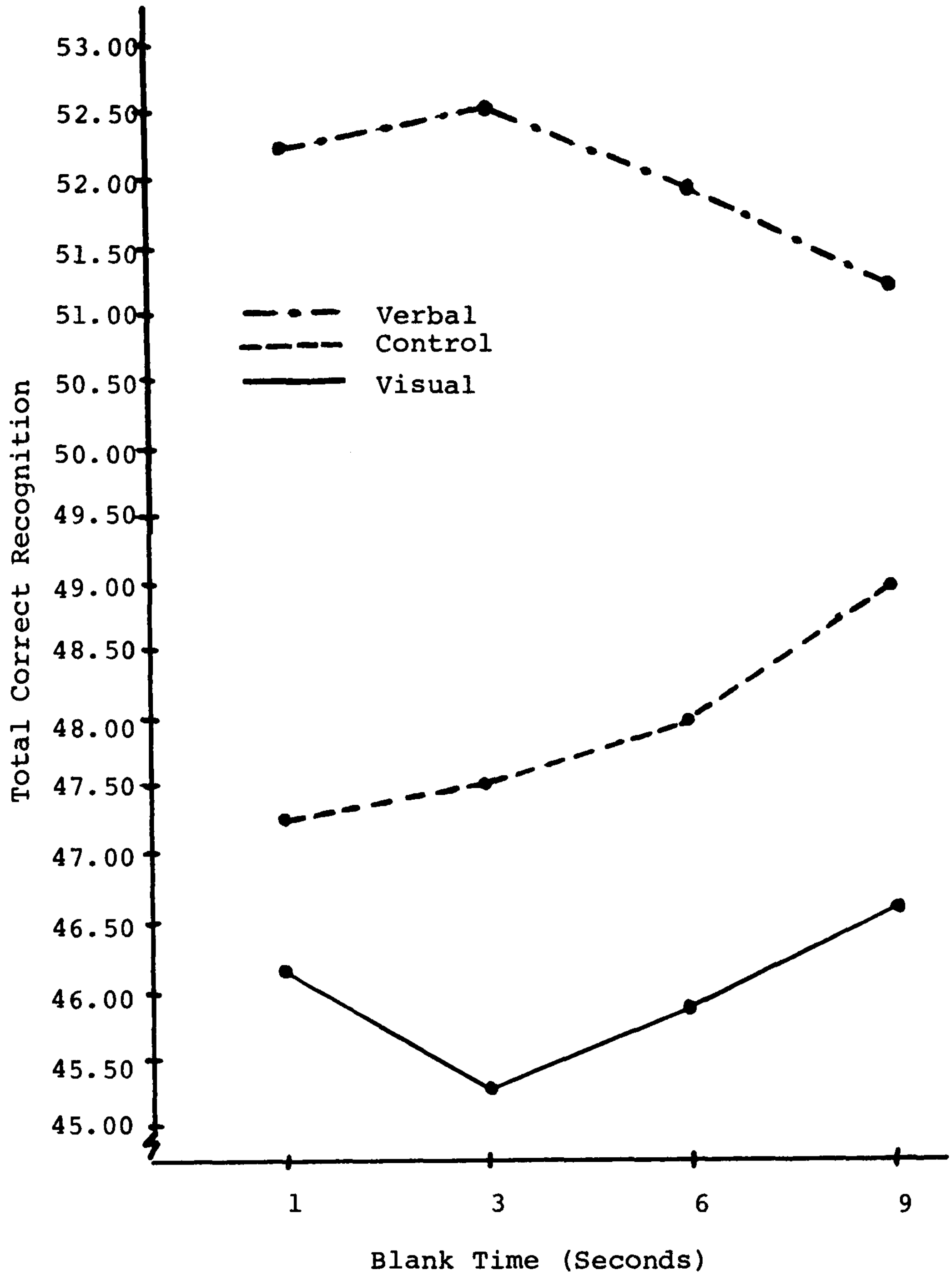


Figure 4. Total correct recognition as a function of blank time and instructions.

effect for fifth and sixth grade students on a picture discrimination task. Their study included three treatment groups: a control group, a group instructed to vocalize the picture labels, and a group instructed to turn away from the pictures and trace the pictures in the air with their fingers. They found that instructions to vocalize and instructions to trace significantly improved retention compared to the control group. They found no significant difference in retention between the two instructional groups, perhaps because of a ceiling effect produced because the performance of both groups was nearly error free.

The total number correct for recognition as a function of blank time and grade is presented in Figure 5. While the college group generally scored highest and the kindergarten group generally scored lowest on all blank time blocks, the pattern for recognition is not as clear-cut as was the case for the recall test. However, the overall effect of grade was significant for recognition, $\underline{F}$ (3, 120) = 3.70, $\underline{p} < .05$.

There were no significant interaction effects for either the recall test or the recognition test.

Post hoc linear trend comparisons showed that there is a significant linear trend for grade for all instructional groups on the recall test: control, $\underline{F}$ (1, 120) =

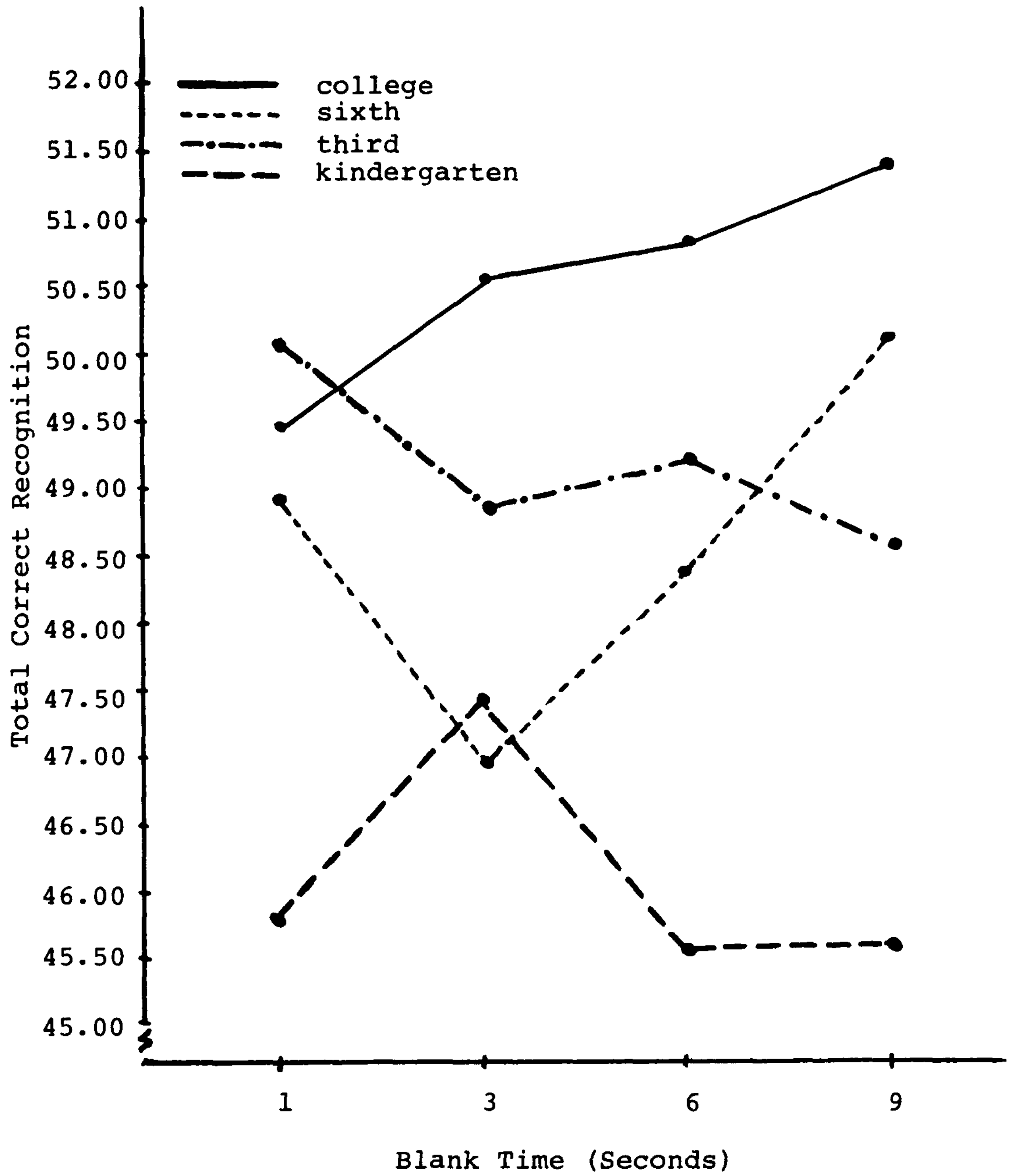


Figure 5. Total correct recognition as a function of blank time and grade.

131.46, $p < .01$; visual, F (1,120) = 115,600.00, $p < .01$; verbal, F (1,120) = 139,389.10, $p < .01$. The recall task proved clearly easier as a person increases in age no matter into which instructional group he/she was placed. Figure 6 shows total correct recall as a function of age and instructional group. However, for the recognition test, there is a significant linear grade trend for only the verbal group, F (1, 120) = 4.00, $p < .05$. Figure 7 shows the total correct recognition as a function of age and instructional group.

Analyses Based on the Hypotheses

Question Set I

Is there a process of visual rehearsal which can be thought of as roughly analogous to the process of verbal rehearsal in short-term memory? Is the process similar in children and adults?

General Hypothesis A: College and sixth grade groups which are given more time to rehearse spontaneously will show more visual memory than these groups will show when they are not given as much time to rehearse.

Experimental Hypotheses:

1. The college control group will show greater recall at the 3, 6, and 9 second blank time intervals than at the 1 second blank time interval.

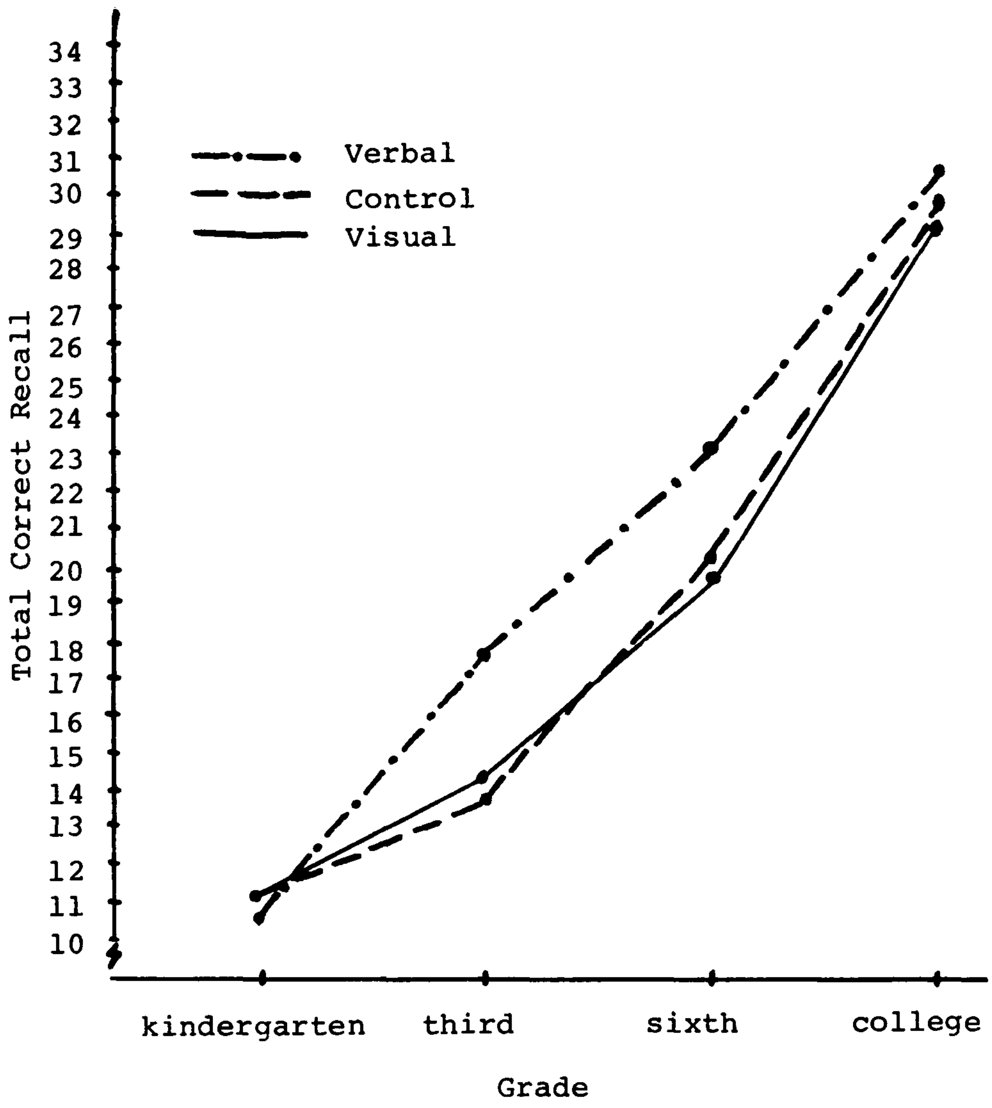


Figure 6. Total correct recall as a function of grade and instructions.

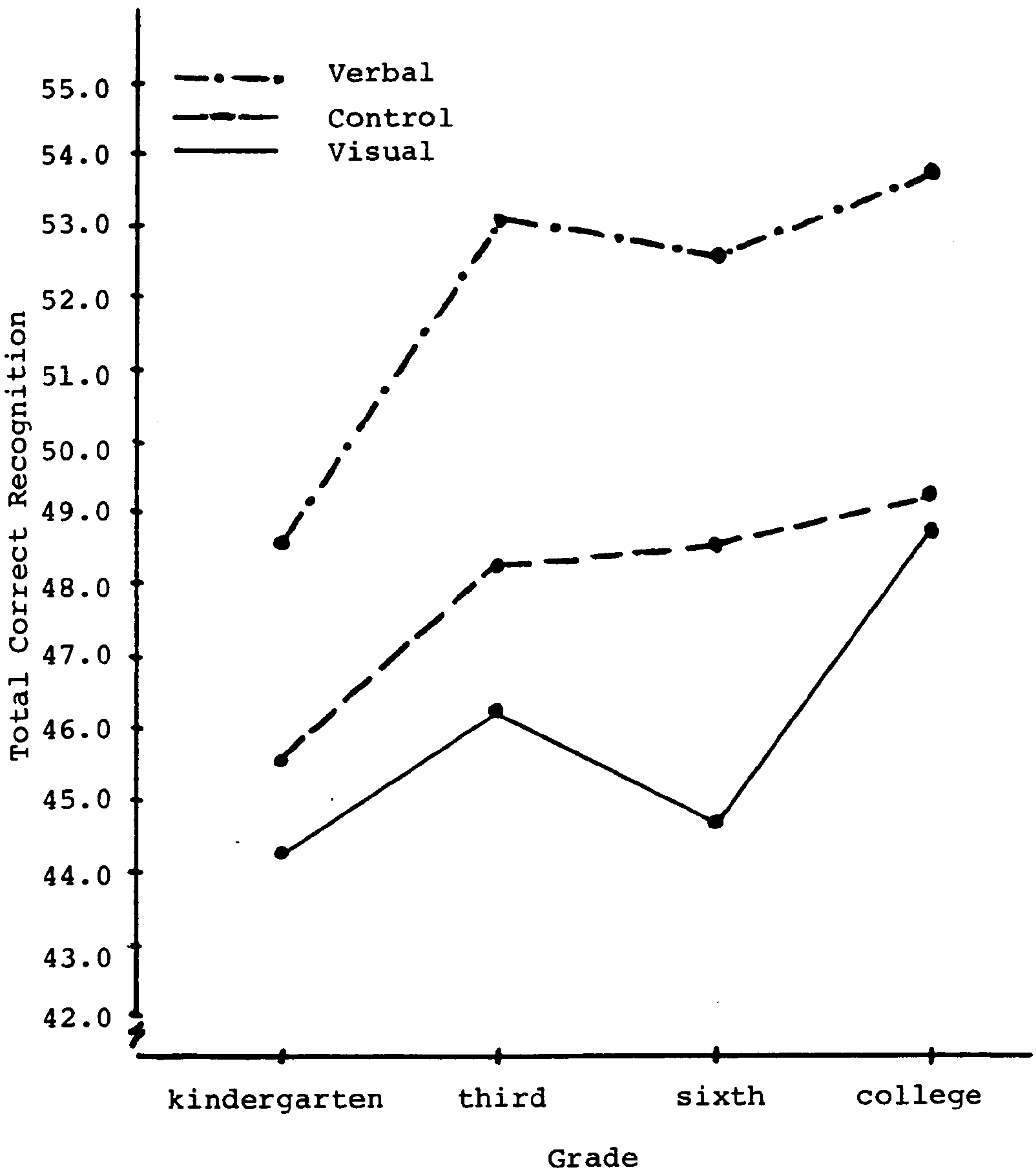


Figure 7. Total correct recognition as a function of grade and instructions.

2. The sixth grade control group will show greater recall at the 3, 6, and 9 second blank time intervals than at the 1 second blank time interval.

3. The college control group will show greater recognition at the 3, 6, and 9 second blank time intervals than at the 1 second blank time interval.

4. The sixth grade control group will show greater recognition at the 3, 6, and 9 second blank time intervals than at the 1 second blank time interval.

Comparisons of blank time drawn directly from the hypotheses under Question Set I were done using $\underline{F}$-tests (Winer, 1971). None of the four comparisons reached significance. Therefore, none of the four hypotheses were supported. Retention did not significantly increase between the 1 second blank time and the 3, 6, and 9 second blank times for either the recall or the recognition tests for the sixth grade control and the college control groups.

For the college group, the results were in disagreement with Tversky and Sherman (1975), who found for undergraduates that there was a significant difference in both recall and recognition for blank time intervals of 1.5 seconds and 3.0 seconds. No control group was used in the Tversky and Sherman (1975) study, however. Their subjects were told of the recall test, and were instructed to categorize or find relationships among the items. Therefore, no direct comparison was possible.

The present data also were in disagreement with the data reported by Weaver (1974), who found for undergraduates that there was a significant difference in recognition for blank time intervals of 2 and 6 seconds. In the Weaver study, however, there was no control group. The subjects were familiarized with the recognition task.

Looking only at the comparisons of 1 second blank time with 3, 6, and 9 seconds blank time, the present results were in agreement with Shaffer and Shiffrin (1972), who found for undergraduates there there was no significant difference in recognition for blank time intervals of 1, 2, and 4 seconds. As in the present study, in the Shaffer and Shiffrin (1972) study, blank time was a within-subjects variable and there was no practice test, nor were encoding instructions given. However, the results of the analyses under Question Set II suggested that the present data cast doubt on the conclusion of Shaffer and Shiffrin (1972) that "complex pictures appear to be processed almost entirely during the period in which they are physically exposed" (p. 292).

General Hypothesis B: Kindergarten and third grade groups which are given more time to rehearse spontaneously will not show more visual memory than these groups show when they are not given as much time to rehearse.

Experimental Hypotheses:

1. The kindergarten control group will show no greater recall at the 3, 6, and 9 second blank time intervals than at the 1 second blank time interval.

2. The third grade control group will show no greater recall at the 3, 6, and 9 second blank time intervals than at the 1 second blank time interval.

3. The kindergarten control group will show no greater recognition at the 3, 6, and 9 second blank time intervals than at the 1 second blank time interval.

4. The third grade control group will show no greater recognition at the 3, 6, and 9 second blank time intervals than at the 1 second blank time interval.

Hypothesis IB1 was rejected. For the control kindergarten group, the 1 second blank time interval on the recall test was significantly worse than the 3, 6, and 9 second intervals, F (1, 360) = 9.31, $p < .01$. This result is probably due more to insufficient verbal processing time for the kindergarten control group at 1 second blank time than to a facilitative effect of subsequent increases in blank time. Table 4 shows the unique result of the kindergarten control group at the 1 second blank time interval.

Table 4

Mean Correct Recall Scores per Blank Time Block for Control Kindergarten and Control Third Grade Groups

	Time Blocks			
Grade	1 Second	3 Seconds	6 Seconds	9 Seconds
Control Kindergarten	1.17	3.42	3.17	3.33
Control Third	3.08	3.50	3.25	4.00

Hypothesis IB3 was supported. The kindergarten control group did not show a significant difference in recognition for the 1 second blank time block compared to the 3, 6, and 9 seconds blank time blocks.

Hypotheses IB2 and IB4 were both supported. The third grade control group did not show greater retention on the 1 second block than on the 3, 6, and 9 second blocks on either of the two measures of retention.

Question Set II

What is the nature or form of visual rehearsal? Is it affected by the subject's age?

General Hypothesis A: College and sixth grade groups which are given the opportunity to spontaneously rehearse will show increased retention with increases in the blank time intervals as measured by both retention tests.

Experimental Hypotheses:

1. For the college control group, there will be a linear trend for recall of visual stimuli on the basis of increases in blank time.

2. For the sixth grade control group, there will be a linear trend for recall of visual stimuli on the basis of increases in blank time.

3. For the college control group, there will be a linear trend for recognition of visual stimuli on the basis of increases in blank time.

4. For the sixth grade control group, there will be a linear trend for recognition of visual stimuli on the basis of increases in blank time.

Linear trend comparisons on blank time based on the hypotheses stated in Question Set II were performed on blank time for college and sixth grade control groups for both the recall and recognition tests. Hypotheses IIA1, IIA2, and IIA4 were supported; hypothesis IIA2 was not supported. The college control group showed a significant linear trend for blank time for both the recall test, F (1, 360) = 4.75, $p < .05$, and the recognition test, F (1, 360) = 4.85, $p < .05$. The sixth grade control group showed a marginally significant linear trend for blank time for the recognition test, F (1, 360) = 3.25, $p < .10$, but not for the recall test.

These results are in agreement with Tversky and Sherman (1975), who found for adults that processing of a picture continues in the blank time between stimuli such that the picture is better retained as measured by both a recall test and a recognition test.

General Hypothesis B: Kindergarten and third grade groups which are given the opportunity to spontaneously rehearse will show no increased retention with increases in the blank time intervals as measured by both retention tests.

Experimental Hypotheses:

1. For the kindergarten control group, there will be no linear trend for recall of visual stimuli on the basis of increases in blank time.

2. For the third grade control group, there will be no linear trend for recall of visual stimuli on the basis of increases in blank time.

3. For the kindergarten control group, there will be no linear trend for recognition of visual stimuli on the basis of increases in blank time.

4. For the third grade control group, there will be no linear trend for recognition of visual stimuli on the basis of increases in blank time.

Contrary to hypothesis IIB1, the kindergarten control group did show a significant linear trend for blank time on the recall test, F (1, 360) = 5.42, $p < .01$. All other hypotheses were supported. The kindergarten control group did not show a significant linear trend for blank time on the recognition test. The third grade control group did not show a significant blank time linear trend in either recall or recognition.

Question Set III

Are instructional sets capable of affecting developmental differences in rehearsal capability? How responsive to instructions are visual codes? Do instructional sets have a differential effect on types of retention tests? Will there be a facilitative effect for children when a "match" exists between input or storage mode and retrieval cues or retention test form?

General Hypothesis A: The visual rehearsal instructions will result in increased retention for the kindergarten and third grade groups on the recognition test.

Experimental Hypotheses:

1. Kindergartners in a visual rehearsal instruction group will show greater recognition than those kindergartners in a control group.

2. Third graders in a visual rehearsal instruction group will show greater recognition than those third graders in a control group.

3. Kindergartners in a visual rehearsal instruction group will show no greater recall than those kindergartners in a control group.

4. Third graders in a visual rehearsal instruction group will show no greater recall than those third graders in a control group.

5. College students in a visual rehearsal instruction group will show no greater recognition than those college students in a control group.

6. Sixth graders in a visual rehearsal instruction group will show no greater recognition than those sixth graders in a control group.

F-tests were performed on the hypotheses stated in Question Set III. No visual group showed greater picture memory than its corresponding control group. Thus, hypotheses IIIA1 and IIIA2 are rejected and hypotheses IIIA3 through IIIA6 are confirmed. Thus, there were no visual instructional effects for either recognition or recall for students in kindergarten, third, and sixth grades or college. These results are contrary to those found by Tversky and Teiffer (1976), who found that a recognition/imagery strategy improved recognition performance for the fifth graders. The results conform with those reported by Levin, Ghatala, DeRose, Wilder, and Norton (1975). They found in their first experiment that the imagery instructional group of fifth and sixth graders did not differ significantly from the control group on a picture discrimination task.

General Hypothesis B: The verbal rehearsal instructions will result in increased retention for the kindergarten and third grade groups on the recall test, but not on the recognition test.

Experimental Hypotheses:

1. Kindergartners in a verbal rehearsal instruction group will show greater recall than those kindergartners in a control group.

2. Third graders in a verbal rehearsal instruction group will show greater recall than those third graders in a control group.

3. Kindergartners in a verbal rehearsal instruction group will show no greater recognition than those kindergartners in a control group.

4. Third graders in a verbal rehearsal instruction group will show no greater recognition than those third graders in a control group.

5. College students in a verbal rehearsal instruction group will show no greater recall than those college students in a control group.

6. Sixth graders in a verbal rehearsal instruction group will show no greater recall than those sixth graders in a control group.

An *F*-test performed on the kindergarten verbal and control groups showed that these groups did not differ significantly on either the recall test or the recognition test as was hypothesized. Hypotheses IIIB1 and IIIB3, therefore, were not supported. However, as hypothesized, the third grade verbal group scored significantly higher on the recall test than did the third grade control group, F (1, 120) = 5.45, $p < .05$, thus confirming hypothesis IIIB2. Hypothesis IIIB4 was not supported. The third grade verbal group showed significantly greater picture memory than the third grade control group as measured by the recognition test, F (1, 120) = 4.21, $p < .05$. These results, that the third grade verbal group outperformed the third grade control group on both the recall test and the recognition test, are contrary to the results reported by Tversky and Teiffer (1976), who found that a recall strategy improved free recall performance at all ages (kindergarten, third, and fifth), but that the recall strategy did not improve recognition performance. The finding that the third grade group's performance was improved with a verbal labeling and rehearsal strategy complements the findings of Levin, Ghatala, DeRose, Wilder, and Norton (1975), who found that vocalization of a picture's label is a highly effective strategy for fifth and sixth grade children on a picture discrimination task.

Hypotheses IIIB5 and IIIB6 were supported. The recall of the college and the sixth grade verbal groups did not differ significantly from their corresponding control groups. The verbal instructions did not facilitate recall for students in kindergarten, sixth grade, or college. Verbal instructions did, however, facilitate recall and recognition for students in third grade.

Additional Analyses

A posteriori comparisons were made on the mean scores across blank time blocks for the instructional groups for both retention tests using the Newman-Keuls technique (Winer, 1971) in order to test for differences between the three instructional conditions. The verbal group scored significantly better than the control group on both the recall test ($p < .05$) and the recognition test ($p < .01$). The visual group was not significantly better than the control group on either the recall test or the recognition test. As a matter of fact, the visual group scored lower than the control group on both tests of retention (see Figures 2 and 4).

The Newman-Keuls technique was used to see if the verbal instructional set was potent enough to overcome the grade effect. On the recall test, where the grade effect is significant $p < .01$, the sixth grade control group performed significantly better than the third grade control group, $p < .01$. However, the third grade verbal group scores and the sixth grade control group scores were not significantly different on the recall test. On the recognition test, neither the sixth grade control/third grade control comparison nor the sixth grade control/third grade verbal comparison reached significance.

The Newman-Keuls technique used on the recall scores for the four grades showed a significant difference, $p < .01$, between all of the grades. However, the Newman-Keuls technique used on the recognition scores for the four grades showed a significant difference, $p < .01$, only between grades kindergarten and college. All other grade comparisons for the recognition test were not significant. Tversky and Teiffer (1976) reported a similar finding that picture recognition performance, given a facilitative recognition strategy, improved with age, but that the improvement started at a later age (between eight and twelve years old) than did recall improvement, given a facilitative recall strategy.

Chapter VI

Discussion

Three sets of questions about the function and properties of visual rehearsal were addressed in this study. The first set of questions sought to establish the existence of a mnemonic strategy within the imagery memory system which would be analogous to the potent mnemonic strategy of "rehearsal" in the verbal memory system. Paivio, in his text Imagery and Verbal Processes (1971), postulates just such a mechanism (p. 131).

It seems clear from the results of the present study that at least two relatively independent memory systems are activated during learning of pictorially presented stimuli. The subjects responded to the recall test and the recognition test by drawing on different information about the stimuli.

The results of the present study cast doubt on the Paivio hypothesis that there is a rehearsal mechanism within the imagery channel which directly parallels verbal rehearsal in the verbal channel. The significant blank time effect found for the free recall task was not matched by a significant blank time effect for recognition. While increases in blank time enhanced recall which required verbalization, increases in blank time did not generally enhance recognition which required visual discrimination. It would appear from the linear trend with positive slope for recall as a function of blank time that further processing of the stimuli was taking place during the intertrial intervals which was helpful for the processing requirements demanded by the free recall task, but not generally helpful for the processing demands of the recognition task. This study found, however, that for college students who were not instructed to use any particular encoding and rehearsal strategy, increases in blank time did have a facilitative effect on recognition. The uninstructed college students were able to make use of the interstimulus intervals in order to further process the visual stimuli in a way which facilitated recognition.

The significant effect of blank time for the recall test is consistent with the results obtained by Tversky and Sherman (1975) who demonstrated that for adult subjects, there is a significant effect on recall for blank times of 1.5 seconds and 3.0 seconds. In the present study, the significant main effect for blank time on recall was demonstrated with children in grades kindergarten, third, and sixth, as well as adults, and for blank times of 1, 3, 6, and 9 seconds. These results were obtained even though, unlike the Tversky and Sherman (1975) study, blank time was a within-subjects variable. Thus, even under conditions which are not optimal for consistency in the use of processing strategies, the blank time effect on recall prevailed.

The comparisons of the 1 second blank time interval with the 3, 6, and 9 second blank time intervals did not yield useful information. Even though there was a significant linear trend for blank time for the recall test, the only control group which showed that the 1 second blank time interval was significantly worse than the 3, 6, and 9 second times on the recall test was the kindergarten group. Inspection of the kindergarten and third grade control groups mean recall scores for each of the four blank times indicated that seven of the eight means ranged from 3.08 to 4.00. The kindergarten control group mean recall score for the 1 second block was 1.17, clearly unique among the eight means. It would seem plausible, then, that this result is due more to the effect of total time (presentation time of 2 seconds and blank time of 1 second) available for initial encoding of the stimuli than to any facilitative effects of subsequent increases in blank time. It was informally noted during data collection that the kindergarten verbal group was much slower to label the pictures and, particularly during the 1 second blank time block, failed to vocalize a label for each picture as instructed. It would seem reasonable to conclude that a total time of 3 seconds per stimulus is too little time for kindergarten children to fully process and verbally encode a series of 60 visual stimuli. As for the other age groups, the amount of recall increased steadily from 1 second to 9 seconds of blank time, but 1 second was not significantly worse than the combined effect of 3, 6, and 9 seconds of blank time. The advantage of increases in intertrial interval was not confined to an increase between 1 second to 3, 6, and 9 seconds. The results showed a pattern of a gradual increase in retention with increases in blank time from 1 to 9 seconds as measured by the recall test.

Concerning recognition, there was no main effect for blank time and, thus, no possibility for a significant linear trend for increases in the intertrial interval. However, both Tversky and Sherman (1975) and Weaver (1974) demonstrated the facilitative effects of increases in blank time on a recognition test for college students. Therefore, it was of a priori interest to look at the effect of blank time on college students separately. In the Tversky and Sherman (1975) study, the adults received a verbal strategy whereby they were encouraged to categorize and find relationships among the pictures and they were prepared for a subsequent recall test. In the Weaver (1974) study, the adults were familiarized with the visual discrimination task required for the recognition test. In the present study, the college student control group received no instructions which suggested any particular encoding strategy, nor did they receive practice in either of the two tests of retention. Yet the control college students displayed a positive linear trend for increases in blank time, a result which is consistent with the results previously reported (Tversky & Sherman, 1975; Weaver, 1974).

These results do not conform with those reported by Shaffer and Shiffrin (1972), who did not find a significant effect for blank time for college students for recognition of pictures. Shaffer and Shiffrin (1972), as in the present study, did not offer a practice test, nor were encoding instructions given. Both exposure time and blank time were within-subject variables which were orthogonally combined and randomly assigned to the sequence of stimuli. In the present study, blank time, while a within-subjects variable, was blocked. Each picture within a group of 15 pictures had the same blank time interval. Presentation time was constant for all pictures. This procedure probably enabled the college-age subjects to develop and employ an encoding and processing strategy which successfully took advantage of the increases in the intertrial intervals.

As with the recall test, the significant linear trend for blank time on the recognition test for the college control group was not matched by a corresponding significant comparison of the 1 second blank time interval with the 3, 6, and 9 second blank time intervals for the college control group. The improvement in recognition as a function of increased blank time was gradual and linear over the entire range of 1 second to 9 seconds blank time for the college control group. No indication was shown of any warm-up effect nor of any ceiling effect.

The second question addressed in this study investigated the effect of age on a recall test and a recognition test of visually presented material. The present study found a positive, strong main effect for age on both the recall and recognition tests. This result is in agreement with Tversky and Teiffer (1976), who found increases in age to be a large factor in the total recall scores of elementary school students.

The significant age trend for recognition conforms with the most recent results of investigations of recognition memory for pictorial information (Dirks & Neisser, 1977; Hoffman & Dick, 1976; Nelson & Kosslyn, 1976;

Tversky & Teiffer, 1976). This age trend for recognition is in contrast to previous failures to observe increases in picture recognition performance with increases in age (Brown, 1973; Nelson, 1971). The present study used a very difficult recognition task which controlled for the commonly encountered ceiling effect for pictures. The average percentages of correct recognition ranged from 76.9% for kindergarten students to 84.4% for college students. Therefore, an age trend for picture recognition can be demonstrated when the task is sufficiently difficult.

The question still remains, however, as to what aspect of visual memory is affected by an intertrial interval. One assumption might be that the image itself is being effectively processed during the blank time. This assumption stems from the visual discrimination requirements of the recognition test for which a verbally encoded response would prove useless in choosing the correct picture. The stringent visual requirements of the recognition test _appear_ to rule out verbal coding alone as an effective memory strategy. And the previously found results (Tversky, 1973; Tversky & Sherman, 1975) of a low correlation between the recall and recognition tests seem to support a view that the recognition test does not tap the verbal code directly. However, recognition performance did not improve with instructions to subjects at four age levels to use a strategy of visual rehearsal of images of the pictorially presented stimuli. "Rapid-fire" rehearsal of images does not appear to be a viable memory strategy. But visual memory can be improved with a simple instruction which, paradoxically, directs the subjects to verbally encode and verbally rehearse the pictures.

These results can be taken to support a model of memory recently presented by Gagné and White (1978). Gagné and White (1978) presented a model of memory structures and their performance outcomes. Implicit in their model are hypotheses regarding effective instruction. The two basic hypotheses are that:

> . . . students' understanding of what is being taught will be deepened to the extent that (a) a greater variety of types of relevant memory structures are stored; and (b) these memory structures become mutually supportive by the development of appropriate links among them. (p. 213)

Gagné and White (1978) defined "memory structure" as "the contents of memory that result from learning, and the organizations that these contents are postulated to have" (p. 188). Gagné and White (1978 further stated that there are four kinds of organized memory structures: (a) networks of propositions, (b) intellectual skills, (c) images, and (d) episodes.

In support of their model of memory, Gagné and White (1978) presented evidence from previous research which showed that both retention and transfer can be improved by using combinations of memory structures rather than single structures. This view of memory would predict that memory in all forms will improve when specific learning in any one of the forms is improved. This is exactly what occurred in the present study when students were instructed to use a verbal strategy. Improvement was not limited to the verbal structure, but also was evident in the imagery structure as shown by the improved recognition performance.

The third general question of this study investigated the effects of two instructions on recall and recognition: a verbal rehearsal strategy and a visual rehearsal strategy. Paivio suggested (1971) that if the memory task encourages "verbalization rather than visual rehearsal," then "rapid decay of the visual information" (p. 131) would result. The present study contradicts this suggestion that a verbal coding of a pictorial stimulus will result in a "decay of the visual information." Quite the contrary. The introduction of a verbal rehearsal strategy, while improving performance of the verbal group on the recall test as predicted, surprisingly, also improved performance on the recognition test. As the Newman-Keuls tests showed, the verbal group significantly outperformed the control group on both the recall and the recognition tests.

The finding that a verbal rehearsal strategy improves recall of pictures is in agreement with previous findings (Tversky & Teiffer, 1976). In the present study, the effect of instruction on recall was significant for third graders. The third grade verbal group outperformed the third grade control group on the recall test. The kindergarteners, given a verbal rehearsal strategy which involved labeling aloud each stimulus upon presentation, then rehearsing the label, did not show a significant gain over the control kindergarten group on the recall test. It would seem that a simple label production deficiency cannot account for the results. The kindergarten children were labeling the pictures (although they did so inefficiently at the 1 second blank time block), but were probably not effective at rehearsing these labels. While more extensive training in a verbal rehearsal strategy has been effective with nursery-school children (Kingsley & Hagen, 1969), a briefly presented instruction to rehearse is not enough training for younger children. The brief instruction, however, was effective at the third grade level.

The verbal rehearsal instructions did not aid the verbal groups vis-à-vis the control groups for either the sixth grade children or the college students. This result is most probably due to the sixth grade and college control groups spontaneous use of verbal rehearsal strategy at these older age levels.

Chapter VII

Conclusion

Clearly, further processing of visually presented stimuli takes place during an interstimulus interval. This further processing is encouraged and facilitated by verbal rehearsal. Evidence of the benefit to learning of pictures by the interjection of blank time can be seen in tests of retention which measure both recall and recognition. Perhaps, for the verbal rehearsal group given pictorial material, the stimulus is dually (or multiply) encoded by subjects from grades three through college. When "verbal rehearsal" of the picture label takes place, rehearsal of all pertinent codes is "rehearsed." Therefore, improvement in both recall and recognition scores can be expected with opportunities to verbally rehearse.

On the other hand, deliberate efforts to visually rehearse using "rapid-fire imagery" are not helpful on either the recall or the recognition tests. As a matter of fact, the visual group at all four ages tested scored lower on the recognition test than did each grade's corresponding control group. Also, a number of college-age students assigned to the visual group volunteered, after completing the experiment, that they had attempted to follow the instructions and found the task extremely difficult or impossible to do. They, then, reverted to other memory strategies which, in the past, had worked for them. Some of these strategies were visually based, such as combining images of the individual pictures to form a unitary picture which had a theme or told a story. One college student reported "seeing" the tree, the tent, and a lion in one picture which she thought of as a safari campsite. During free recall, she named the tent and the tree, but not the lion, which she thought she had added to the scene in order to complete the theme. Another college subject reported visualizing a sailboat on the river which flowed under the bridge, while an airplane flew overhead. He recalled all three items on the free recall test.

It would seem possible that if a more sophisticated visual process involving organizing and categorizing pictures were attempted as an instructional set, then perhaps the visual group would perform better on the recognition test than the control group. It is questionable, though, whether the elaborated visual group would outperform the verbal rehearsal group on the recognition test. The demonstration that a very simple instruction to label and verbally rehearse given to third graders can result in increased recall and recognition, is very impressive. Clearly, this study does not support the notion that verbal rehearsal will limit the amount of visual information retained by the subjects. On the contrary, it would seem possible that the use of verbal rehearsal either increases retention of the visual information per se or else simultaneously makes more accessible for retrieval both the verbal and visual information stored for each item.

The present study found that recognition performance does improve with age. A task which required the construction and remembering of a mental image was performed better by adults than children. However, the development of visual memory through the school years is far more gradual than is the development of verbal memory. Recall was significantly improved with every grade change studied (kindergarten to third to sixth to college). Recognition, on the other hand, was gradual from kindergarten through sixth grade. There was no significant difference in recognition between the students in kindergarten and the students in sixth grade. Recognition improved significantly only from kindergarten to college.

The response of the children and adults to the instructions to visually rehearse was clear-cut. They could not follow the directions or else they did not benefit from the instruction. Visual rehearsal, if such a concept has a viability in memory theory, cannot be easily taught to children or enhanced in adults. The poor performance on the recognition test of the visual group suggests that attempts to consciously visually rehearse may even have an interfering effect on recognition.

Implications for Education

The results of this study of visual and verbal rehearsal strategies of pictures in children and adults has a number of implications for education.

First, visual rehearsal, per se, is not a mnemonic strategy which can be used spontaneously by elementary-school children. Children do not use time between visually presented information for "rapid-fire" repeating of the images developed to signify those pictures.

Second, instructing children to rehearse images of visual experiences is not indicated by this study to be a valuable teaching method. A covert imagery instruction, without the addition of other mnemonic strategies, such as tracing or verbalization, does not improve children's memory for pictures.

Third, teaching techniques which emphasize verbalizing visual experiences are indicated by this study to be helpful techniques, especially for the middle elementary-school years. Verbal rehearsal of pictures increases the amount of information that young children recall about pictures they have seen. Labeling and verbal rehearsal have been shown to be mnemonic strategies which improve recall of pictures and which can be quickly and easily learned by young children.

And finally, teaching techniques which emphasize verbalizing visual experiences will not diminish the image of that experience. Emphasizing the words to appropriately express visually presented information will, on the contrary, improve elementary-school children's recognition of that information and will aid them in discriminating that particular information from similar information.

The overall implication to education of this study is that verbalizing and verbally rehearsing an experience which has stimulated the construction of an image does not diminish or destroy that image. On the contrary, labeling and verbally rehearsing the labels will improve the image. Elementary-school children can profit from instructions to put their experiences into words. Teaching young children verbal memory strategies not only improves their recall of the words associated with an experience or perception, but also enhances the internalized perception itself.

Appendices

Appendix A

Stimuli Labels and Acceptable Synonyms

	Stimuli	Synonyms Used by Verbal Subjects During Presentation
1.	television	T.V.; television set
2.	fish	
3.	tricycle	bicycle; bike
4.	barn	farm; barnyard, barn and fence; (fence)*
5.	refrigerator	
6.	horse	jumping horse
7.	dress	clothes; skirt; girl's dress
8.	luggage	suitcases; suitcase; traveling bags; bags; baggage
9.	lion	tiger; lion . . . male
10.	tractor	(bulldozer)
11.	chair	
12.	castle	kingdom; sandcastle
13.	rabbit	bunny; jack rabbit; bunny rabbit; (leopard, a thing that was jumping from one place to another)
14.	house	(cottage)
15.	scissors	scissor
16.	cake	birthday cake
17.	umbrella	

Stimuli		Synonyms Used by Verbal Subjects During Presentation
18.	trolley	bus; trailer; trolley car; trolley bus; tram; truck
19.	tent	
20.	purse	pocketbook; bag; suitcase; handbag
21.	meat	steak; porkchop; piece of meat; beef; side of beef
22.	pig	hog
23.	typewriter	
24.	bicycle	bike; two-wheeler
25.	camera	
26.	truck	garbage truck; pick-up truck; wagon
27.	frying pan	pan; (skillet)
28.	train	
29.	cup and saucer	cup; mug; pitcher; teacup; coffeecup; (place setting)
30.	spear	arrow; spade; stick; (pointy stick)
31.	tree	
32.	girl	girl's face; face; person
33.	haystack	hay; hut; stacks of hay; grass hut; (teepee); (wigwam)
34.	teapot	coffee pot; kettle; pot; tea-kettle
35.	sailboat	boat
36.	sock	
37.	clock	

Stimuli		Synonyms Used by Verbal Subjects During Presentation
38.	lawnmower	grasscutter; mow; mower
39.	shoe	
40.	butterfly	
41.	trunk	chest; treasure chest; box; toychest; safe
42.	flowers	
43.	hat	
44.	airplane	plane; (airport)
45.	shirt	jacket; coat; (blouse)
46.	lamp	light; (lamppost)
47.	car	a man driving a car; (a taxi driver)
48.	rug	mat; towel; picture; tapestry; carpet; (something wrapped up like a candybar)
49.	pipe	cigarette; smoke pipe
50.	iron	steam iron; telephone
51.	pea pod	peas; corn; seeds; beans, peas in a pod; (vegetables)
52.	stairs	steps; stair; staircase
53.	desk	table; dresser
54.	cow	
55.	fireplace	chimney; fire
56.	bridge	tunnel; road; tunnels; river; water; aqueduct
57.	mouse	rat; (gerbil); (squirrel)

Stimuli	Synonyms Used by Verbal Subjects During Presentation
58. picture	picture of fruit; picture frame; fruit; book; painting; picture of pears; (bowl of fruit); (pear)
59. telephone	phone
60. battleship	boat; ship; sailboat

* Words in parentheses are synonyms not used by verbal subjects during presentation, but used during the free recall test and deemed acceptable synonyms by the two judges.

Appendix B

Twelve Sequences of Blank Times

1. 9, 1, 3, 6 seconds
2. 3, 6, 9, 1 seconds
3. 3, 9, 6, 1 seconds
4. 6, 1, 3, 9 seconds
5. 9, 3, 1, 6 seconds
6. 1, 6, 9, 3 seconds
7. 1, 9, 6, 3 seconds
8. 6, 3, 1, 9 seconds
9. 9, 6, 1, 3 seconds
10. 6, 3, 9, 1 seconds
11. 1, 6, 3, 9 seconds
12. 3, 9, 1, 6 seconds

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