

IMAGERY CHARACTERISTICS AS RELATED TO
PICTURE-WORD STIMULUS VARIABLES
AND PRESENTATION RATES IN
PAIRED-ASSOCIATE LEARNING

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This is to certify that the
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PICTURE-WORD STIMULUS VARIABLES
AND PRESENTATION RATES IN
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ABSTRACT

IMAGERY CHARACTERISTICS AS RELATED TO PICTURE-WORD STIMULUS VARIABLES AND PRESENTATION RATES IN PAIRED-ASSOCIATE LEARNING

By

Wilma Lois Patterson

The present study addressed itself to the investigation of imagery differences in the learning of pictorial and word stimulus-digit paired-associate items. High and low imagery groups were defined by a combined standard score distribution involving the Flags Test and the Space Relations Test. The imagery-defining tasks were administered during the first experimental session; PA lists were administered in a second experimental session. Volunteer Ss were obtained from Michigan State University, Lansing Community College and a high school honors program. Complete data were collected from 80 female Ss.

The Ss learned five PA lists: two concrete stimulus lists administered at two second rates, two concrete stimulus lists administered at eight second rates, and an abstract list administered

at two second rates. The concrete lists consisted of words rated high on imagery, concreteness and meaningfulness; the abstract words were high in meaningfulness and low in rated imagery and concreteness values. All lists consisted of high frequency words. The four concrete lists were equated for imagery, concreteness and meaningfulness values. The concrete stimulus lists were each symbolized in both picture and word form. The abstract list stimulus members were always words. Response members for each list were the digits two through nine. Each S learned a two second concrete list with pictures as stimulus members, a two second concrete word stimulus list, an eight second picture stimulus list, an eight second concrete word stimulus list and the two second abstract word list. There were eight paired items per list. List sequences were presented in two different orders. Within-list randomizations were used across all learning and test trials.

The PA lists were filmed and presented to groups of Ss. Four different film strips were used (corresponding to list order sequences and picture-word stimulus variations). Subjects were given five learning trials and five test trials on each list. Learning and test trials were alternated. The learning criterion was total number of errors across the five trials. Subjects gave written responses in the booklets provided.

Nine of the ten experimental hypotheses were supported. High imagery Ss performed better on picture stimulus lists; low imagery Ss performed better on concrete word stimulus lists, and high imagery Ss performed better on the abstract word list. Both subject groups performed better under the eight second versus the two second presentation times; however, high imagery Ss improved more from the shorter to the longer presentation rates, so that, under the eight second rate conditions, high imagers performed as well as low imagers on the concrete word stimulus lists.

The results were discussed in relation to inferred imagery and verbal mediation styles. No evidence was obtained to indicate that the high and low imagery groups differ in intelligence test scores or overall learning ability. Correlational data were interpreted as indicating that imagery ability may play a facilitating role in mechanical comprehension. Implications of the results and suggestions for future research were presented.

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1970

Dedicated to Bufford Steffle,
whose living will be remembered
for a long, long time

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INTRODUCTION

Review of the Literature

In 1883 Galton reported finding pronounced individual differences in clarity of mental imagery. For the next twenty or thirty years a search was conducted for "pure" imagery types (visual versus auditory versus kinesthetic, etc.) (Griffitts, 1927). The primary finding from this research period was that most individuals possess several types of imagery and can, to some extent, employ these abilities selectively according to task demands (Betts, 1909). Also, during this period the legitimacy of the reliance on introspection (on which the imagery data heavily depended) for the uncovering of the operations of "mind" was being seriously challenged. In 1913 Watson unceremoniously debunked the whole business, declaring that ". . . psychology must discard all reference to consciousness. . . ." (Dennis, 1948, p. 461).

In the United States the banishment of imagery (following Watson's pronouncement) remained almost total until the 1950's; however, the British filled this interim period with an ongoing argument which was distinguished primarily by its thinly-disguised

evaluative tone of whether the imagers or non-imagers were the "good guys" (e.g., Hicks, 1924; Pear, 1924). The other remaining pocket of interest during this period was the German investigations of eidetic imagery phenomena in children¹ (Jaensch, 1930).

Holt (1964) attributes the re-emergence (and absolution) of imagery investigations to a variety of divergent sources. Sensory deprivation research received its impetus from the existence of

¹The following definitions are taken from Holt (1964, p. 255).

Image: generic term for all conscious subjective presentations of a quasi-sensory but nonperceptual character.

Thought image: a faint subjective representation of a sensation or perception without an adequate sensory input, present in waking consciousness as part of an act of thought. Includes memory images and imagination images; may be visual, auditory, or of any other sensory modality, and also purely verbal.

Hypnagogic image (or hypnagogic hallucination): an image, usually so projected (that is, "out there") and of such vividness, clarity, and detail that it approaches sensory realism, appearing suddenly to someone in the drowsy state just before sleep. When such an image occurs at a corresponding period of awakening, it is called hypnopompic. It may be visual or auditory; sometimes other modalities occur and are included under this heading.

Eidetic image: a projected image (generally visual) of such vividness, color, clarity, and differentiation of form as to seem to the fully waking subject (usually a child) like a percept. Jaensch (1930) described two types: the T type, resembling greatly prolonged afterimages and generally in complementary colors to the original, and the B type, resembling greatly enhanced thought images.

some very pressing problems encountered by pilots, truck drivers and others who found themselves troubled by vivid imagery, sometimes temporarily mistaken for reality. "In such a situation, practical people are not likely to be impressed by the argument that imagery is unworthy of study because it is 'mentalist' and virtually impossible to experiment on with animals" (Holt, 1964, p. 257). Early sensory deprivation literature abounds with ominous sounding terms like hallucinations, but gradually, as demand characteristics of the experiments were manipulated and Ss' (subjects') attitudes toward these and similar experiences were investigated, the descriptive terminology toned down. Further impetus for imagery investigation may be traced to such diverse points of interest as hallucinogenic drugs, "flying saucer" reports and the workings of creativity. The recent advances in electroencephalography, direct stimulation of the brain and dream research have each contributed to the respectability of imagery research. Penfield and Jasper (1954), for example, in directly stimulating the temporal lobe cortex obtained reports of both visual and auditory imagery. Several investigators (e.g., Barratt, 1956; Short, 1953) have investigated alpha wave phenomena in relation to visual imagery. Photic stimulation has been used (Freedman & Marks, 1965) as a method of experimentally inducing the visual imagery experience.

Of greatest interest for the present investigation has been the renewed attention paid to the role of imagery in cognitive psychology. This literature will be treated in greater detail later in this review. First, however, it should be mentioned that Holt failed to note the most ironic re-emergence of imagery in the field of psychology. Visual imagery ability is accorded a central role in Wolpe's (1958) desensitization or reciprocal inhibition brand of behavior or conditioning psychotherapy in that a S's (patient's) anxiety response to snakes, for example, is extinguished by a procedure which includes having the person image the feared object.

The possible role of imagery in cognition was reintroduced in the literature by Roe (1951). She asked her Ss (scientists from various fields) ". . . in what form thoughts were handled by them" (p. 461). She found that men in a particular vocation tended to use the same type of imagery (e.g., biologists reported visual imagery while psychologists reported verbal thought forms). Roe suggested that the tendency to use one as opposed to another form of imagery might be a determinant of vocational choice.

Imagery found its way into the paired-associate, serial learning and free recall literature when investigators became interested in the facilitating role of implicit mediators in the associative process. Negative results notwithstanding (e.g., McNulty,

1966), numerous investigators have reported the superiority of verbal and visual mediating techniques (versus repetition) in verbal learning (Delin, 1969; Paivio & Yuille, 1967). Using low meaningful paralogues (e.g., meardonzumap) in a paired-associate (PA) experiment, Martin, Boersma, and Cox (1965) found that they could classify Ss' reported associative strategies into seven categories along a complexity continuum. They further reported a significant positive linear relationship between complexity level of the associative strategy and correct item performance. Davidson (1964) found that PA learning of pictures was facilitated by E's (experimenter's) providing of prepositions between the stimulus and response item names.

Most investigators concerned with mediating devices have supplied their Ss with instructional sets to use verbal or visual imagery techniques in forming their associations. In a free recall experiment, Wood (1967) found that both subject groups supplied with "peg words" or instructed to link items through the formation of bizarre images performed significantly better than Ss given no mediating instructions. Berla, Persensky, and Senter (1969) have reported similar results. Yarmey and Thomas (1966) reported that imaginal set instructions facilitated concrete noun PA learning, whereas verbal mediating set instructions interfered with the

learning of abstract nouns. On the other hand, Reese (1965) obtained results which suggested that verbal mediation was more helpful than visual imagery. Berg and Worchel (1956) reported that verbal mediation was more helpful than visual imagery on maze learning tasks; however, they also obtained results suggesting that the facilitating effect of the mediational process varies with task dimensions. Further evidence for such an interactional effect was obtained by Paivio and Yuille (1967). Their analysis revealed that learning was equally effective (and superior to repetition) regardless of mediating set instructions (imagery or verbal set); however, post-learning reports revealed that Ss changed mediational techniques depending to some extent upon the image-evoking and meaningfulness attributes of the stimulus materials. Additional variance in the data seems to be attributable to subject style in that some Ss, for example, reported using imagery even though instructed to use verbal mediation and under the conditions of being presented with low imagery nouns as stimuli.

The importance of stimulus characteristics is again emphasized by the finding that Ss (in the absence of experimenter-supplied mediating set instructions) report using imagery significantly more frequently in associating concrete items than abstract items (Paivio, Yuille, & Smythe, 1966). In the same study, it was found that on

concrete items Ss reporting imaginal mediators performed significantly better than Ss reporting verbal mediators; however, the differences between the mediational groups were not significant when the items were abstract.

Reaction time data (Paivio, 1966; Yuille & Paivio, 1967) have revealed that imagery mediational set latency is significantly affected by the concreteness-abstractness of stimulus items, while verbal mediational set latency is considerably less affected by this stimulus dimension. Paivio (1966) reported correlations of $-.70$ between independently rated item imagery and imaginal RT and $-.46$ between rated imagery and verbal RT. Such findings are interpreted to indicate that verbal "... symbolic processes and images are equally available as mediators when the stimulus ... is concrete, but only verbal mediators are readily aroused when the stimulus is abstract" (Yuille & Paivio, 1967, p. 543).

Much evidence is available to indicate that verbal learning is superior for concrete (versus abstract) material (e.g., Epstein, Rock, & Zukerman, 1960; German, 1961; Klein, Hale, Miller, & Stevenson, 1967; Paivio, 1963, 1965, 1967b). These results are most clearly attributable to concreteness, per se, in those studies (e.g., Paivio, Yuille, & Smythe, 1966) which have equated the concrete and abstract materials for variables such as frequency and

meaningfulness which are also known to affect learning. Obtained imagery and concreteness ratings are so highly correlated that they are considered functionally equivalent usually, and no attempt is made to separate them; Paivio (1968) reported a correlation of .88 between I (Imagery) and seven-point C (Concreteness) ratings for 96 nouns.

Since concreteness is defined in terms of object reference, it follows that objects themselves (or their pictorial representations) are more concrete than their verbal labels. Results are again rather consistent in revealing the superiority of performance when the materials to be learned are objects or pictures of objects as opposed to the names of the same objects (e.g., Bousfield, Ester-son, & Whitmarsh, 1957; Corsini, Jacobus, & Leonard, 1969; Jenkins, Neale, & Deno, 1967; Rohwer, Lynch, Levin, & Suzuki, 1967; Sampson, 1969; Wimer & Lambert, 1959). Paivio, as has been noted, has pointed out that when materials are concrete, both visual and verbal mediating devices are readily available. It would appear that the advantage which objects and pictures as stimuli have over concrete words must be largely attributable to the differences in their imagery-evoking characteristics, since it does not seem likely that verbal mediation would be less readily evokable by concrete labels (i.e., words) than by pictures or objects. It should

also be noted, however, that some researchers have reported superior learning of verbal material as opposed to picture material (Dilley & Paivio, 1968). Such results are often interpreted as reflecting the difficulty of decoding a visually stored item into a verbal response form rather than as an indicator of inferior storage of visual material (Corsini, Jacobus, & Leonard, 1969; Paivio, 1969).

Paivio has developed the "conceptual peg hypothesis" as a result of his investigations of mediation in PA learning.

The reasoning was that the stimulus member of a pair of nouns serves as a mnemonic peg to which its associate is "hooked" during learning trials, when stimulus and response members are presented together, and from which the response member can be retrieved on recall trials, when the stimulus member is presented alone. On the assumption that imagery can serve a mediating function, as the imagery memory technique suggests, it was argued that the ease of learning the stimulus-response association would depend partly on the image-arousing capacity of the individual nouns and the stimulus member in particular. The imagery-value of both stimulus and response would contribute to the formation of a compound image, consisting of images evoked by the individual items when the two are presented together, thereby affecting the acquisition of the mediated association. On recall trials, however, when the stimulus is presented alone, the image-arousing value of the stimulus member would be particularly important, for the stimulus must serve as the cue that reinstitutes the compound, mediating image from which the response component can be retrieved and re-coded as a word. The hypothesis leads to the prediction that a positive effect of noun imagery would be greater on the stimulus side than on the response side of pairs. It was reasoned further that concrete nouns such as "house" would elicit images more readily than abstract nouns such as "truth," therefore paired-associate

learning of nouns would be particularly facilitated when the stimulus noun is concrete. To extend the metaphor, concrete nouns should be more "solid" conceptual pegs than abstract nouns. (Paivio, 1967b, pp. 7-8).

Paivio maintains that it is crucial for the conceptual peg hypothesis that imagery and concreteness values should have a greater effect on the stimulus item side than on the response item side in PA learning. Results have generally support this interactional expectation (Paivio, 1965, 1967a; Paivio & Madigan, 1968; Paivio & Yuille, 1966; Yarmey & Paivio, 1965). However, other investigations have revealed no differential effect of imagery-concreteness values dependent upon stimulus or response placement (Paivio, 1963; Wood, 1967).

It may be concluded from the literature reviewed that visual imagery is oftentimes a useful and readily employed mediating device in verbal learning. In a recent factor analytic study, in fact, high imagery values of stimulus items emerged as the best single predictor of PA learning (Paivio, 1968). Thus, a S''s attempt to use and success at using imagery as a mediating device depends in part, sensibly enough, on how readily the materials to be learned lend themselves to this approach (their "picturability"). A second determinant of imagery use is the S''s awareness that imagery can be used; investigators have dealt with this variable by informing their Ss of this fact and instructing them to employ this associational

and mnemonic device. A third variable (in addition to item characteristics such as concreteness) which seems to affect the success with which a mediational device can be employed is presentation time. Yuille and Paivio (1967) supplied their Ss with either imaginal or verbal mediation sets and varied concreteness-abstractness among stimulus and response PA items. Subjects were instructed to signal the E when they found an appropriate mediator for each pair of items. The overall latency mean under the imagery set was 9.75 seconds, 8.62 seconds under the verbal mediation set. For Ss under the imagery set, latency increased significantly as items decreased in concreteness; no such trend occurred for Ss under the verbal mediation set. In a reaction time experiment (Paivio, 1966), imaginal set RT was again found to be slower than verbal set RT, with the set difference increasing as a function of the abstractness and generality of the word stimuli. Wallace, Turner, and Perkins (1957) allowed Ss to work at their own pace (but told them to form associations as quickly as possible) and instructed them to use imagery in forming PA connections. Subjects learned eight lists of 25 pairs each; the mean association time per pair on the first list was 20.4 seconds, 3.0 seconds per pair for the last three lists. Incidentally, accurate recall in this experiment was about 99 per cent up to 500 pairs and 95 per cent for the recall of 700 pairs.

Wood (1967) obtained evidence to indicate that mediation strategy in PA learning increases in effectiveness as a function of item presentation time, mediating instructions being relatively ineffective at two second presentation rates and becoming significantly more effective (than lack of mediational instructions) at five second presentation rates. Bugelski (1962) varied presentation rate and found that many ". . . Ss reported inability to learn until a mediator of some type did occur. The longer the inter-item interval (6, 8, 10, 12, or 19 seconds) the more likely the occurrence of a mediator" (p. 411). Bugelski, Kidd, and Segmen (1968) instructed Ss to use imagery in a serial learning task; they found that the imagery instructions actually impaired learning under a two second presentation rate but was a significantly superior learning device (compared to a no mediation or standard control group) under an eight second presentation rate. It should be mentioned that in the great majority of PA investigations a two-three second presentation rate has been employed.

A fourth variable which would be expected to influence the choice and efficiency of imagery as a mediating device is the S's propensity and skill for visualization. Individual differences in imagery use and ability have been frequently reported (e.g., Griffiths, 1927). This inter-subject stylistic variable has been

neglected to a great extent in the recent verbal learning literature. This lack of expressed interest in individual imagery differences is probably most directly attributable to the fact that appropriate tasks, on the basis of which one could define imagery groups, have not been readily available.

Recently, Sheehan (1967a, 1967b) has revised Betts' imagery questionnaire and has shown that Ss varying in reported vividness of imagery also vary on other relevant dimensions. He reported, for example, that, contrary to some theorizing about imagers, high imagery Ss are less likely than low imagery Ss to confabulate in memory and more likely to accurately reinstate the perceptual process (Sheehan, 1966). Barratt (1953) administered 23 spatial group tests to two samples of Ss (the first involving male and female undergraduates, the second, males only, ranging in age from 14 years, 3 months to 19 years, 3 months). Barratt isolated three factor groupings in his first study and confirmed them in the second study. Each of the tests clustering together on one factor (spatial manipulation) seemed to involve the ability to manipulate visual-imaginal processes. Barratt hypothesized that ". . . if imagery plays any part in thinking it is in just such tasks" (p. 157) that it should be manifested. During the original testing, after each test the Ss looked back over the items and rated imagery

as a component of their problem solving. The Ss' ratings were summed over the tests to obtain a total imagery score for each S. Next, Barratt computed total imagery scores for tests across all Ss. He then determined that Ss who rated the imagery factor tests as high in their own use of imagery in their problem solving performed significantly better on these tests than Ss rating the same tests low in problem solving imagery.

An absence of sex differences in imagery performance has been reported by several investigators (e.g., Davis, 1932; Griffiths, 1927; Sheehan, 1967b). Christianson and Stone (1968) obtained some evidence to indicate that, in their sample of 12 year old Ss, males appeared to be better visualizers than females.

Two studies have been reported in which learning as a function of inter-subject imagery style was investigated. In an investigation of visual imagery in children, Kuhlmann (1960) used the Flags Test from the Personnel Classification Series (one of the spatial manipulation factor tests studied by Barratt); she found that children varying in test performance were differentially effective in remembering pictures as opposed to forming and recognizing concepts. Stewart (1965) utilized the Flags Test in conjunction with the Spatial Relations Test from the Differential Aptitude Tests battery to obtain her high and low imagery groups among college

females. She reported correlations between the two tests of .586 and .626. She found no IQ differences (WAIS vocabulary) or school achievement differences between her high and low imagery groups. Stewart conducted three different memory experiments and found support for her hypothesis that high imagery Ss would benefit most when the concreteness of the learning situation was increased. This finding is consistent with the larger body of literature on experimenter-supplied imagery set.

Stewart's first experiment will be partially replicated and extended as part of the present study and, thus, will be presented in some detail. In this PA experiment, stimuli were 16 common objects symbolized as drawn pictures or as words. Each S learned both lists, one with pictures as stimuli and one with words as stimuli; the response items were always digits ranging from two through nine. The learning criterion was to one correct trial. Presentation rate was two seconds per pair.

Both high and low imagers learned the pictures faster than the words, and high imagery Ss learned the picture stimulus list in fewer trials than the low imagers, while the low imagers learned the word list in fewer trials than the high imagers. Also, the difference in learning rates for the picture and word stimuli was significant for high imagery Ss but not for low imagery Ss. Another

result relevant to the present study was the evidence Stewart obtained which suggested that, in memory, high imagery Ss were more likely to code a word as a picture. Low imagery Ss were more likely to code a picture as a word.

Present Study

Rationale and Plan

The relative superiority of learning the picture stimuli shown by the high imagery over the low imagery Ss (Stewart's finding) is consistent with the assumption that imagery ability allows one to keep "observing" visual stimuli after their perceptual removal. In other words, use of imagery could function to give high imagery Ss more exposure or longer "trials" in the learning situation. However, it would also appear logical to assume that high imagery Ss could employ their imagery just as readily to visualize words. Were imagery skills put to this use, high imagers, it seems, should have also equalled or surpassed the performance of low imagers in learning the associations involving the word stimuli.

To conceptualize the high imagers' performance decrement from picture to word stimuli, it was postulated that these Ss recoded the word stimuli, via imagery, into pictures. As mentioned, in

another phase of her study, Stewart found evidence to indicate that high imagery Ss do tend to code (and store) word stimuli as pictures. Also, an examination of the stimulus words used by Stewart (see Appendix A) revealed words all of which refer to concrete objects which the high imagers could readily transform into pictures. This hypothesized transposition from word-digit association into a picture-digit association would have to be "reconverted" or decoded back into word form or somehow equated with the word stimuli before the response could be made. It was further assumed that this recoding and decoding back and forth takes time (see Yuille & Paivio, 1967, for example) and in this way could cause errors and increase the number of trials required to reach the criterion. It will be remembered that Stewart used a two second presentation rate.

In the present study, Stewart's two original eight item PA lists were included at the two second presentation rate used by her. In addition, two additional eight item PA lists were constructed. A more detailed description of the PA lists is given in the following chapter. However, at this time, it should be mentioned that the newly constructed lists were devised so that they were comparable to Stewart's two PA lists along the dimensions of frequency, imagery and meaningfulness values. As with Stewart's two lists, the additional lists (the four lists being discussed may be referred

to as concrete stimulus PA lists) were each symbolized in both picture and word stimulus form.

In order to experimentally approach the coding-decoding speculations previously presented, the newly constructed concrete PA lists were administered at eight second presentation and recall rates. It was expected that these increased time rates would enhance high imagers' performance, compared to the more rapid condition (two second presentation and recall rates) used for Stewart's two concrete PA lists. Such improved performance would be expected as a function of more sufficient time for the process of recoding and decoding (of word to picture and picture to word stimuli) to take place.

It was also expected that low imagery Ss would use the longer time rates to improve their performance, as compared to the two second presentation and recall rate condition. However, the high imagery Ss were expected to make a proportionately greater gain than low imagers between Stewart's original and the new concrete stimulus conditions.

In a second extension of Stewart's study, an abstract word stimulus PA list was constructed. This eight item PA list was equated with Stewart's two PA lists along the dimensions of frequency and meaningfulness values. At the rapid presentation and

recall rates employed (two seconds), low imagery Ss were expected to show the usually reported decrement in performance with abstract stimuli (for example, Paivio, 1963, 1965, 1967b).

The issue was more complicated for high imagery Ss. It was reasoned that should these Ss persist in trying to recode these abstract words into pictures, especially under these rapid presentation and recall rates, their performance would suffer accordingly. In this case, performance on abstract words should be significantly inferior to performance on concrete words under the same rate condition.

On the other hand, it was felt more likely that the experimental conditions of abstractness and rate might sufficiently discourage attempts by high imagers to recode these words into mental pictures. In such an event high imagery Ss might employ their visualization skills to "picture" words as words. This modification of imagery use (which still involves imagery) would seem to be most consistent with a "high imagery style"; although, Ss might also change to verbal mediation or resort to mere repetition under the abstract stimulus condition.

These postulated alternative approaches (versus persistent attempts to recode abstract words into pictures) were thought to be consistent with previous reports that pure, inflexible imagery

"types" have been rarely found (e.g., Betts, 1909) and that Ss have tended to change (experimenter-supplied) mediating devices depending, in part, on characteristics of the stimuli to be learned (Paivio & Yuille, 1967). On the basis of the above reasoning and the limited evidence available, it was postulated that high imagery Ss would perform better under abstract than concrete word stimulus conditions at rapid presentation rates.

As a control variable, Verbal, Numerical and Total scores from the College Qualification Test (Bennett, Bennett, Wallace, & Wesman, 1957) were compared for the high and low imagery groups. Stewart (1965) reported that imagery groups were not differentiated by intelligence test vocabulary scores or by school achievement records. Ernest and Paivio (1969) used a measure of associative fluency (as a control for verbal ability) and found that high and low imagers did not differ in their verbal production scores.

The Test of Mechanical Comprehension (Form AA) (Bennett, 1940) was originally included in the present study since it was expected that, on the basis of normative data, male and female Ss would exhibit differential performances on the imagery-defining tasks selected, the Flags Test (Form A) (Thurstone & Jeffrey, 1956) and the Space Relations Test (Form A) (Bennett, Seashore, & Wesman, 1947). It was reasoned that such differential performance

would not be due to imagery differences between the sexes per se (see previously reviewed research noting a lack of sex differences in imagery) but to differential mechanical ability skills reflected in the Flags and Space Relations scores. It was expected that both the Flags Test and Space Relations Test would correlate more highly with the Test of Mechanical Comprehension for male Ss than for female Ss.

Unfortunately, these speculations remain a moot point since it was not possible to obtain a sufficiently large male sample to include in the present study. However, the data which were collected from the female Ss included the scores from the Test of Mechanical Comprehension; these data will be presented, hopefully as a reference point for future studies.

To make the experimental hypotheses more understandable to the reader, an overview of the present study will be presented at this point. Each S learned five eight-item PA lists; four lists were concrete stimulus lists; the remaining list involved abstract stimuli. Each S learned two of the concrete lists (a two second and an eight second list) with pictures as stimuli and the other two concrete lists with words as stimuli. The abstract word list and Stewart's (1965) two concrete lists were administered at a two second presentation rate and a three second recall rate. Two newly

constructed concrete lists were administered at eight second presentation and recall rates.

Hypotheses

The experimental hypotheses for the present study are presented below. The hypotheses are grouped first according to expected differences on the concrete stimulus lists; the second group of hypotheses pertain to expected differences involving the abstract stimulus list as well. In both cases, expected differences are presented first for high imagery Ss, then for low imagery Ss and, finally, for high versus low imagery Ss.

Hypothesis I

High imagery Ss will make fewer errors on the two second picture stimulus lists than on the two second concrete word stimulus lists.

Hypothesis II

High imagery Ss will make fewer errors on the eight second concrete word stimulus lists than on the two second concrete word stimulus lists.

Hypothesis III

High imagery Ss will make fewer errors on the eight second picture stimulus lists than on the two second picture stimulus lists.

Hypothesis IV

Low imagery Ss will make fewer errors on the eight second concrete word stimulus lists than on the two second concrete word stimulus lists.

Hypothesis V

Low imagery Ss will make fewer errors on the eight second picture stimulus lists than on the two second picture stimulus lists.

Hypothesis VI

High imagery Ss will make fewer errors than low imagery Ss on the picture stimulus lists.

Hypothesis VII

Low imagery Ss will make fewer errors than high imagery Ss on the two second concrete word stimulus lists.

Hypothesis VIII

High imagery Ss will make fewer errors on the two second abstract word stimulus list than on the two second concrete word stimulus lists.

Hypothesis IX

Low imagery Ss will make fewer errors on the two second concrete word stimulus lists than on the two second abstract word stimulus list.

Hypothesis X

High imagery Ss will make fewer errors than low imagery Ss on the two second abstract word stimulus list.

METHOD

Subjects

Subjects volunteered to participate in the present study with the understanding that two experimental sessions were required. Ninety-one female Ss participated in the first experimental session. Nine Ss were not available for the second experimental session; the data from two Ss who participated in both experimental sessions were eliminated from the analysis because of their failure to understand the experimental task.

Subjects were recruited from classes and residence halls at Michigan State University (70 Ss), from Lansing Community College (seven Ss) and from an honors group of high school students (three Ss). Sixty-five of the University Ss were undergraduates; five were graduate students. Six of the Ss received experimental credit in an introductory psychology course for their participation in the study. The 80 Ss ranged in age from 17 to 25. Prior to the experiment, Ss were informed only that the two experimental sessions would involve "pencil and paper 'figure' tests and a simple learning task."

Materials and Apparatus

Test Materials

The operational definition of imagery was derived from the Flags Test and the Space Relations Test. The Flags Test has a five minute time limit; the Space Relations Test has a 30 minute time limit.

The Test of Mechanical Comprehension has no time limit; however, most Ss complete the test in 20 to 25 minutes, and little is gained by allowing more than 30 minutes (Bennett, 1940). In the present study a 30 minute time limit was set.

Response booklets for the PA task were constructed. Page dimensions of the booklets were approximately $5\frac{1}{2} \times 4$ inches; pages were attached at the top by two $\frac{3}{4}$ inch metal rings which permitted rapid turning of the pages. The booklets consisted of 25 numbered test pages, each of which contained eight blank spaces for recording the appropriate PA responses. The test pages were separated by blank pages of colored paper. In addition, the booklets consisted of a cover sheet on which the S's experimental number was recorded and an example test page at the beginning of the test booklet.

Stimulus Characteristics
of the PA Lists

Paivio, Yuille, and Madigan (1968) have presented rated imagery, concreteness, meaningfulness and frequency values for 925 nouns. Several of the stimulus nouns Stewart (1965) used to construct her two PA lists appeared among these rated nouns. Stewart's two PA lists were used in the present study. Three additional lists were also constructed for use in the present study: two concrete stimulus lists and one abstract stimulus list. The noun stimuli for the two concrete PA lists were selected for values within or near the range values of Stewart's nouns (see Table 1).

TABLE 1

Imagery, Concreteness and Meaningfulness Values
of the Concrete Stimulus Lists

	Imagery	Concrete- ness	Meaning- fulness
Stewart's combined lists (I and II)			
Mean	6.54	7.09	7.28
Range	6.43-6.73	6.93-7.70	6.48-7.68
New concrete list (III)			
Mean	6.63	6.97	7.15
Range	6.50-6.87	6.93-7.00	6.38-7.96
New concrete list (IV)			
Mean	6.63	6.92	7.39
Range	6.50-6.77	6.90-7.00	6.79-7.88

High frequency nouns (A and AA) were used in each of the four concrete PA lists. The concrete PA lists were considered "equivalent forms" since important list characteristics known to affect learning (imagery, concreteness, meaningfulness and frequency) were equated across the four lists.

The abstract word list was constructed of high frequency nouns (A and AA) from the Paivio, Yuille, and Madigan (1968) list. On the basis of the mean values presented by these authors, words were selected which were higher than average on meaningfulness values and below average on imagery and concreteness values. Table 2 presents the mean and range values for the eight abstract nouns used in the present study, as well as the mean values for the total sample of 925 nouns for which Paivio, Yuille, and Madigan have given imagery, concreteness and meaningfulness values. The five word lists and pictorial stimulus items for the four concrete lists are presented in Appendix A and B, respectively.¹ Response elements were the digits two through nine for each of the five PA lists used in the study (see Appendix A).

¹Appendix B also contains a picture of the frame in which the stimulus and response cards were placed for filming.

TABLE 2

Imagery, Concreteness and Meaningfulness Values
for the Abstract Stimulus List and
for a Normative Word List

	Imagery	Concrete- ness	Meaning- fulness
Abstract list (V)			
Mean	3.03	2.84	6.35
Range	2.13-3.60	1.56-4.49	6.04-6.91
Paivio, Yuille, and Madigan nouns (1968)			
Mean	4.97	4.95	5.81

Presentation Order
for the PA Lists

Each S learned five PA lists. For five lists there are 120 possible orders of presentation; this permutation of 120 does not include the additional picture-word stimulus variations among the four concrete PA lists. Originally, from among the 120 possibilities, five different test sequences were randomly selected (the random selection was limited by the restriction that each of the five PA lists would appear first in one of the five selected list order sequences). Unfortunately, the original plan to present five different list order sequences could not be implemented because of the prohibitive filming costs (see the following section dealing with

presentation techniques) involved in the study. Therefore, two list order sequences were chosen for use in the present study. These list order sequences were chosen at random except for the restriction that one of the sequences would begin with a two second concrete list (one of Stewart's two PA lists), while the other would begin with an eight second concrete list (one of the two concrete PA lists constructed for the present study). The two list order sequences were I, III, II, V and IV (list order 1) and IV, V, II, III and I (list order 2).²

Each list was presented for five learning trials and five test trials; therefore, within-list randomization orders were included in the design to prevent serial learning. The within-list randomization orders for learning trials and test trials are presented in Appendix C. These orders apply to each of the five PA lists.

² Stewart's PA list containing the stimulus items: book, ear, fish, key, leaf, pear, pencil and watch, will be referred to as list I (or concrete list I). Stewart's PA list containing the stimulus items: apple, cane, cup, eye, fly, glasses, house and shoe, will be referred to as list II (or concrete list II). The new PA list (Patterson's PA list) containing the stimulus items: arm, car, mountain, boy, table, door, bottle and flag, will be referred to as list III (or concrete list III). Patterson's PA list containing the stimulus items: tree, bird, diamond, ship, fire, potato, flower and coin, will be referred to as list IV (or concrete list IV). Patterson's PA list containing stimulus items: soul, position, justice, knowledge, development, history, evidence and answer, will be referred to as list V (or abstract list).

Table 3 diagrammatically presents the two list order sequences and the variations within these sequences for picture-word stimulus presentations (indicated by "A" and "B") on the four concrete PA lists. The "X" notation indicates picture or word stimulus presentation. The subscript notation for "X" reflects the list order sequence. Reading from Table 3, S number 11 received list order sequence 1B (I, III, II, V, IV); this S learned PA lists I and IV with word-digit pairings, lists II and III with picture-digit pairings. Subject number 10 learned the same list order sequence but with the reverse picture/word combinations. List V, the abstract list (low in picturability, by definition) always consisted of a word-digit pairing.

Presentation Technique for the PA Lists

The traditional technique for gathering PA learning data has been to expose each S individually to a memory drum presentation of the material. An aim of the present study was to devise a method by which the PA material could be presented to groups of Ss. Filming of the PA material presented itself as an appropriate method which would permit the collection of group data.

A balsa wood frame was constructed in which the stimulus and response PA material was placed for filming. The outside

dimensions of the frame were $13\frac{1}{2} \times 9\frac{1}{4}$ inches; these dimensions corresponded to and encompassed the viewing dimensions of the camera used for filming. The frame was divided into two sections by a $\frac{3}{8}$ inch vertical balsa wood strip. The left-hand portion of the frame (inside dimensions) was $7\frac{3}{4} \times 7\frac{5}{8}$ inches; the right-hand portion of the frame (inside dimensions) was $3\frac{5}{8} \times 7\frac{5}{8}$ inches. The stimulus and response PA materials were reproduced on white poster board sections that fit the frame dimensions. The stimulus materials (pictures, words and instructions) fit the left-hand portion of the frame; the response materials (digits and presentation rate and PA list number information) fit the right-hand portion of the frame. The frame was painted black and secured against a black vertical surface.

The stimulus words used by Stewart (1965) were pica type, 12-point, letters. Stimulus words for the five PA lists used in the present study were enlarged to 60-point size. The words were centered on white poster board and printed in solid, black, clarendon-medium type.

Stimulus members of all pairs on the four concrete lists were symbolized in both picture and word form. Pictures for concrete lists I and II were enlarged proportionately, with a pantograph, from the pictures Stewart (1965) presented in her

study. The picture stimuli for concrete lists III and IV were drawn by the E and were comparable in size to the proportionately enlarged pictures for lists I and II. All pictures were drawn with black india ink on white poster board (see Appendix B).

Response members for each of the five PA lists were the digits, two through nine. The digits were put on white poster board in 72-point, solid, black, futura-bold type.

The written instructions which were filmed were also put on white poster board. The instructions were printed in 60-point, solid, black, futura-bold type.

The PA material was filmed with a Canon zoom 518, Super 8 movie camera. The camera was mounted and stabilized four feet from the vertical frame. The zoom lens was adjusted to coincide with the frame dimensions. The film used was Kodachrome II, Super 8, color movie film. Although the filmed material was black and white, colored film was used, on the advice of a professional photographer, to insure a high quality of processing and developing.

Illumination during the filming was provided by a 75 watt, overhead, room light and a Bell and Howell/Canon movie light (model 3000) mounted on the camera. The 120V-650W DVY lamp

was directed toward the material to be filmed so that glare was minimized.

Concrete lists I and II and abstract list V were filmed at a two second rate during learning trials (during which picture-digit or word-digit pairs were shown) and a three second rate during test trials (during which only the picture or word stimulus items were shown).³ Concrete lists III and IV were filmed at an eight second rate during both learning and test trials. All instructions were filmed at an eight second rate. A stopwatch was used during filming to time the rate conditions. During test trials, a blank piece of white poster board was filmed in the response portion of the frame.

Two list order sequences, each with two picture-word variations, were filmed (see Table 3). The individual rolls of film were spliced appropriately. It was necessary to wind each of the four PA films onto two separate reels. For each film, the first three PA lists filled one reel, and a second reel was used for the remaining two PA lists. During the experimental sessions, the reels were changed in approximately two minutes.

³The three second test trial rate was selected in order to give the Ss time to record their responses.

Procedure

First Experimental Session

During the first experimental session the Space Relations Test, Flags Test and Test of Mechanical Comprehension were administered. Several different sessions had to be scheduled in order to obtain a sufficient number of Ss. For each group session the tests were presented in the order stated above. The test materials provided instructions; the E told Ss when to begin and when to stop each test. Each S left her phone number and completed a schedule card indicating times when she would be available for the second experimental session.

To obtain the high and low imagery groups for the second experimental session, scores from the Space Relations Test and Flags Test were standardized and combined into one distribution. Subjects scoring above the median on this combined distribution constituted the high imagery group; Ss scoring below the median constituted the low imagery group.

Subjects were contacted for the second experimental session so that 10 high imagery and 10 low imagery Ss were presented with one of the four film strips: list order 1A, 1B, 2A or 2B (see Table 3). Subjects were assigned to the list order sequences so that the number of Ss scoring more than one standard deviation

above and below the mean and within one standard deviation above and below the mean were distributed across the four order conditions.

Second Experimental Session

During the second experimental session Ss were presented with the filmed PA task. The Kodak M 80 Instamatic Super 8 movie projector was placed 12 feet from a standard movie screen (surface area of 40 square inches). At this distance, the projected image was 24×12 inches. Subjects were seated 12 to 15 feet from the movie screen. Overhead illumination was sufficient for reading the written instructions and for recording responses.

At the beginning of the experimental session, Ss were given their response booklets, pencils and written instructions. Except for the necessary modifications, the instructions closely followed those used by Stewart (1965). The instructions follow.

This is an experiment in memory. In front of you is a movie screen. I will show you a picture or a word that will be paired with a digit from 2 to 9. Your task is to learn which digit goes with which picture or word. That is, I want you to learn which number is paired with which picture or word.

You will learn 5 lists; some of the lists will have pictures paired with digits; other lists will have words paired with digits. Some lists will be presented at the rate of 2 seconds per pair, other lists at 8 seconds per pair. All items on any

one list will be either picture-digit or word-digit pairs and will be presented at the same time rate.

First, in succession, you will be shown the pairs together. There will be 8 pairs altogether for each list. The pairs will appear on the screen at the rate of either 2 seconds or 8 seconds per pair. Then, following the 8 pairs, you will see, in succession, only the 8 pictures or words, without the numbers. Your task will be to write down the digit that goes with each picture or word as quickly as you can. You will have only 2 or 8 seconds to recall the digit before the next unpaired picture or word appears. After seeing all 8 unpaired pictures or words, then I will show you both members of the 8 pairs again, only in a different order than before. After seeing the 8 pairs together, then you will see only the picture or word half of the pair and again you will write the appropriate paired digits in your booklet. For each list you will have five learning trials (where you see both members of each pair) and five test trials where you will see only the picture or word, and you will write the digit. Learning and test trials will be alternated. Also, even if you cannot remember the correct digit, I would like you to guess anyway.

Open your booklet to the example test page (the second colored sheet in your booklet); there are 8 spaces like those where you will write your responses on the test sheets. Your white test pages where you will actually write your responses are numbered (for example, Test Page 1). You will be told when to turn to a Test Page. You will then write your digit as each picture or word is shown on the screen. I would like you to guess the correct digit so that each of the 8 blank spaces is filled. If you cannot guess, please write in a zero so you will not put the remaining digits in the wrong blank. After the 8 pictures or words have been shown, you will be instructed on the film to turn the page again; leave your booklet turned to this colored page until you have seen all 8 paired numbers again, and you are again instructed on the film to turn to the next Test Page. And so forth. I will show you a filmed example before we begin.

You will be informed before each new list starts. Also before each list begins you will be informed of the 2 or 8 second presentation rate. Turn your booklet back to the cover sheet with your experimental number on it. Any questions?

After Ss had read the written instructions, the film was begun. Each of the four film strips began with an example and further instructions.

One picture (word) and digit at: 2 sec. rate (8 sec. rate)/
[example picture-digit (word-digit) pair] / Turn to example
test page/[example picture (word)] / Record digit on first line
(correct: 1)/ Turn to the following colored page. Watch the
screen for your first learning task/ You will be told when to
turn to test page. We are ready to begin.

If the first PA list to be seen by Ss was picture-digit pairs at the two second rate (list order 1A), then the filmed example was a picture-digit pair shown at a two second rate. If the first PA list to be seen was word-digit pairs at the eight second rate (list order 2B), then the filmed example was a word-digit pair shown at an eight second rate. The same format of appropriate examples was used for list orders 1B and 2A.

Subjects were informed (on film) before each new list began and at what rate it would appear. They were also instructed (on film) when to turn the pages in their response booklets. The film strips were approximately 40 minutes long.

Following the experimental task, the E explained the nature of the experiment to the Ss and answered their questions. The Ss showed a high level of interest in the study, and these

post-experimental discussions lasted from 15 to 45 minutes.

Subjects were asked not to discuss the nature of the experiment until all groups had been tested. There was no evidence that the Ss violated this confidence.

RESULTS

Preliminary Findings

Subjects were divided into high and low imagery groups on the basis of the median from the combined standard score distribution of the Space Relations Test and the Flags Test (see Table 4). An $\underline{F}$ test for homogeneity of variance between the imagery groups was calculated. A nonsignificant $\underline{F}$ was obtained, indicating that the homogeneity requirement was fulfilled ($\underline{F} = 1.65, p > .05$).

TABLE 4

Combined Standard Score Distribution Measures
for the Imagery-Defining Tasks:
Flags Test and Space Relations Test

	High imagery $\underline{Ss}$	Low imagery $\underline{Ss}$
Standard score range	51-76	16-50
Standard score mean	59.58	40.08
Standard score standard deviation	7.35	9.43
N	40	40

As descriptively presented in Table 5, it can be seen that $\underline{Ss}$ obtained from different sources were not disproportionately represented in the high or low imagery groups.

TABLE 5
High and Low Imagery $\underline{Ss}$ by Sample Source

	High imagery $\underline{Ss}$	Low imagery $\underline{Ss}$
University undergraduate students	33	32
University graduate students	3	2
Community College students	2	5
High school honors students	2	1
Total N	40	40

The Space Relations Test and Flags Test were significantly related ($r = .54$). The correlation obtained in the present study does not differ significantly ($z = .41$) from that reported by Stewart (1965).

The Test of Mechanical Comprehension was significantly related to both the Space Relations Test ($r = .59$) and the Flags Test ($r = .51$). The partial correlation coefficient between the Space

Relations Test and the Flags Test, with the influence of the Test of Mechanical Comprehension removed, remained significant

($r_{12.3} = .35$, $t = 3.27$, $p < .001$).

College Qualification Test Scores were available on 63 of the Ss. These high and low imagery Ss did not differ on Verbal, Numerical, or Total CQT scores (see Table 6).

TABLE 6
College Qualification Test Scores
for High and Low Imagery Ss

	Verbal	Numerical	Total
High imagery <u>Ss</u> N = 33			
Mean	55.03	30.50	131.60
SD	10.23	8.90	21.60
Low imagery <u>Ss</u> N = 30			
Mean	55.60	27.77	128.90
SD	11.80	9.15	25.13
t	< 1.00	1.19	< 1.00
p	ns	ns	ns

Method of Data Analysis

The paired-associate group testing procedure employed in the present study involved an equal number of learning trials (five

trials) for all Ss. Thus, the number of trials to one (or sometimes two) correct trial (which is often employed in verbal learning experiments) was not an appropriate learning criterion to apply to the data. The learning criterion employed in the present study was number of errors. Although number of trials to a correct trial is a more frequently employed performance criterion, the use of error scores is certainly not without precedent (e.g., Delin, 1969; Kornreigh, Kane, & Straka, 1969; Seitz, 1969; Wolfgang, 1969; Yelen, 1969).

The data from the four concrete stimulus paired-associate lists were analyzed by a $2 \times 2 \times 2$ repeated measures design (Winer, 1962). The three factors were imagery (high and low imagery groups), stimuli (pictures and words) and presentation time rates (two seconds and eight seconds).

A 2×2 repeated measures design was employed to analyze the data from the two second concrete word stimulus lists in conjunction with the two second abstract word stimulus list. The two factors were imagery (high and low imagery groups) and stimuli (concrete words and abstract words). The .05 probability level was required for significance in the first analysis. Since the second analysis (the 2×2 repeated measures design) involved the use of some data which had appeared in the first analysis (the two second

concrete word stimulus lists data) the .01 probability level was required for significance.

Main Findings

First Analysis

Table 7 contains the mean error scores and standard deviations for the two imagery groups under the four treatment conditions. The summary three factor analysis of variance is presented in Table 8.

TABLE 7

Mean Error Scores for High and Low Imagery Groups
under the Four Treatment Conditions

	Pictures		Words	
	2 seconds	8 seconds	2 seconds	8 seconds
High imagery Ss N = 40				
Mean	1.83	0.68	7.53	1.33
SD	1.50	0.82	6.14	1.33
Low imagery Ss N = 40				
Mean	4.75	2.30	3.48	1.35
SD	3.69	2.03	2.86	1.27

TABLE 8

Analysis of Variance for High and Low Imagery Ss
under Two Paired-Associate Stimulus Conditions
(Picture versus Words) and Two Presentation Rate
Conditions (Two Seconds versus Eight Seconds)

Source of variance	SS	df	MS	F
Between subjects				
Imagery (A)	1.38	1	1.38	0.15
Subjects	711.37	78	9.21	
within groups				
Total	712.75	79		
Within subjects				
Stimulus (B)	85.08	1	85.08	10.36**
A × B	367.65	1	367.65	44.78***
B × Subjects	640.02	78	8.21	
within groups				
Presentation				
rate (C)	711.03	1	711.03	89.44***
A × C	38.50	1	38.50	4.84*
C × Subjects	620.22	78	7.95	
within groups				
B × C	111.63	1	111.63	11.33**
A × B × C	144.45	1	144.45	14.66***
B × C × Subjects	768.67	78	9.85	
within groups				
Total	3487.25	240		

* $p < .05$

** $p < .005$

*** $p < .001$

The nonsignificant F (.15) associated with factor A (Imagery) indicates that high and low imagery Ss did not differ in overall learning performance. This finding is consistent with the nonsignificant CQT performance differences reported on a portion of the total sample of high and low imagery Ss . Stewart (1965) also failed to find overall learning differences between her high and low imagery females.

The significant F (10.36) associated with factor B (picture-word stimuli) indicates that picture stimuli were learned with fewer errors than word stimuli. This finding is consistent with that reported by Stewart (1965). The significant AB interaction ($F = 44.78$) indicates that high imagery Ss learned picture stimulus lists better than word stimulus lists; on the other hand, low imagery Ss learned the word stimulus lists better than the picture stimulus lists. The significant imagery $\times$ stimulus interaction is graphically illustrated in Figure 1.

The significant AB interaction was examined further by the Scheffé method of mean comparisons (Hays, 1963). Hypothesis VI is accepted. The hypothesis is restated below.

Hypothesis VI

High imagery Ss will make fewer errors than low imagery Ss on the picture stimulus lists.

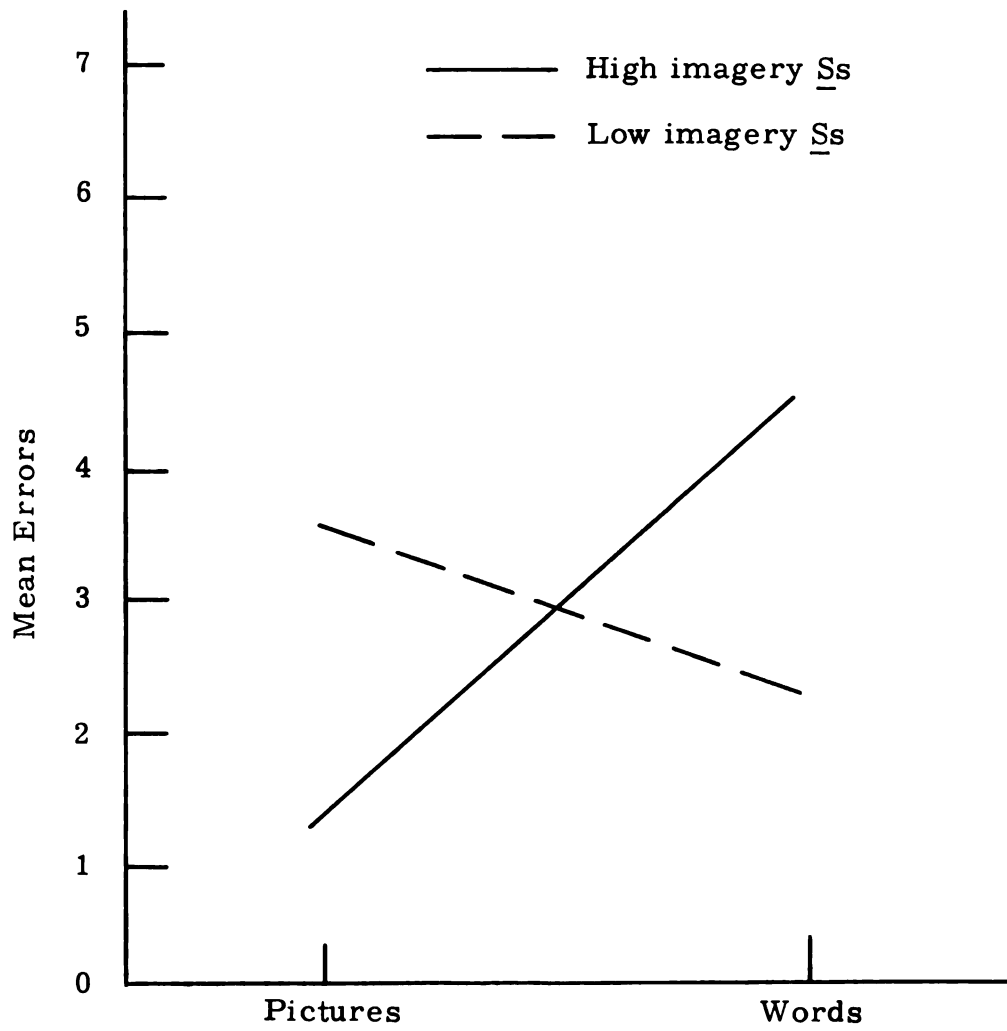


Fig. 1. --Imagery $\times$ stimulus interaction: mean error scores.

The confidence interval of $\hat{\psi}$ (psi capped) indicated that the comparison was significant at the investigated probability level of .05 ($\hat{\psi} = 3.17$ to 1.37).¹ This finding that high imagery Ss performed better than low imagery Ss on picture stimuli accords with Stewart's (1965) finding. An additional comparison within the significant AB interaction also indicated that low imagery Ss learned words with significantly fewer errors than high imagery Ss ($\hat{\psi} = 2.92$ to 1.12). This result also coincides with Stewart's findings. No explicit hypothesis was postulated in the present study with respect to imagery differences in concrete word stimulus learning for the combined two and eight second word lists (which is the comparison reflected in the AB interaction).

Two further comparisons indicated that, again for combined two and eight second lists, high imagery Ss learned picture stimulus lists significantly better than concrete word stimulus lists ($\hat{\psi} = 4.08$ to 2.28); low imagery Ss learned the concrete word stimulus lists significantly better than picture stimulus lists ($\hat{\psi} = 2.01$ to $.21$). Stewart (1965) also reported this superior performance of high imagers on pictures versus words. However,

¹A psi capped confidence interval indicates that a given comparison is significant at an investigated alpha level (.05 in the present study) when the range does not cover zero.

Stewart's low imagery Ss also learned picture stimuli better than word stimuli, although these learning differences were not significant. No hypotheses were postulated in the present study with respect to these latter two combined presentation time findings. Findings pertaining to differences between and within the imagery groups for two and eight second lists considered individually will be discussed in relation to the ABC interaction.

The significant main effect for factor C ($F = 89.44$) indicated that Ss made significantly fewer errors on the lists presented at eight second rates versus lists presented at the two second rate. No hypothesis was postulated for this rather obvious result. The main effect was again compromised by significant interactions. The significant AC interaction ($F = 4.84$) is presented graphically in Figure 2. The interaction reflects the finding that low imagery Ss made fewer errors than high imagery Ss under two second rate conditions, while under eight second rate conditions high imagery Ss made fewer errors. Scheffé comparisons revealed that high and low imagery Ss did not differ significantly in learning under two second rates ($\hat{\psi} = 1.46$ to $-.02$) nor under eight second rates ($\hat{\psi} = 1.72$ to $-.06$) for combined picture and word list stimuli conditions. Within imagery group comparisons revealed that both high and low imagery Ss performed better under the longer presentation time

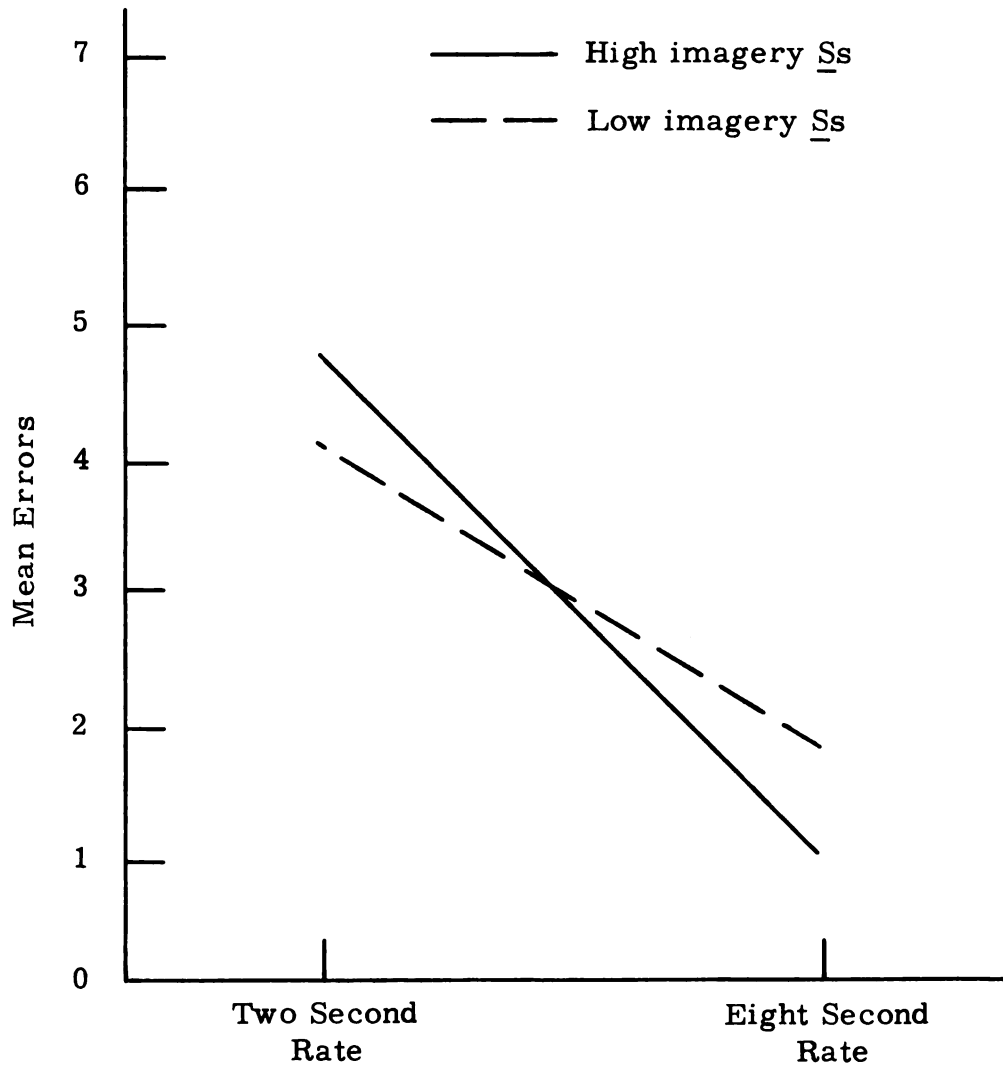


Fig. 2. --Imagery $\times$ presentation rate interaction: mean error scores.

rate ($\hat{\psi} = 4.57$ to 2.79 and 1.72 to $.942$, respectively). Inspection of Figure 2 reveals that high imagery Ss made a proportionately greater performance improvement from the shorter to the longer presentation rate than did the low imagery Ss. It is also evident in Figure 2 that this differential improvement cannot be attributed to a ceiling effect for low imagery Ss. This latter trend, although not presented as a formal hypothesis, was expected.

The BC interaction was also significant ($F = 11.33$) and reflects that under two second rate conditions, picture stimulus lists were learned with fewer errors than concrete word stimuli; under eight second rate conditions, word stimuli were learned with slightly fewer errors. These data are presented graphically in Figure 3. Scheffé comparisons revealed that the picture versus word stimuli differences were significant under the two second rate conditions but not under the eight second rate conditions ($\hat{\psi} = 3.20$ to 1.22 , $.15$ to $-.99$, respectively). Individually, both picture and word stimulus lists were learned with significantly fewer errors under the eight second rate conditions than under the two second rate conditions ($\hat{\psi} = 2.79$ to $.81$, 5.15 to 3.17 , respectively). Inspection of the means presented in Table 7 reveals that the poor performance of high imagery Ss on concrete word stimuli under the rapid presentation time rate condition contributed greatly to the main effect and

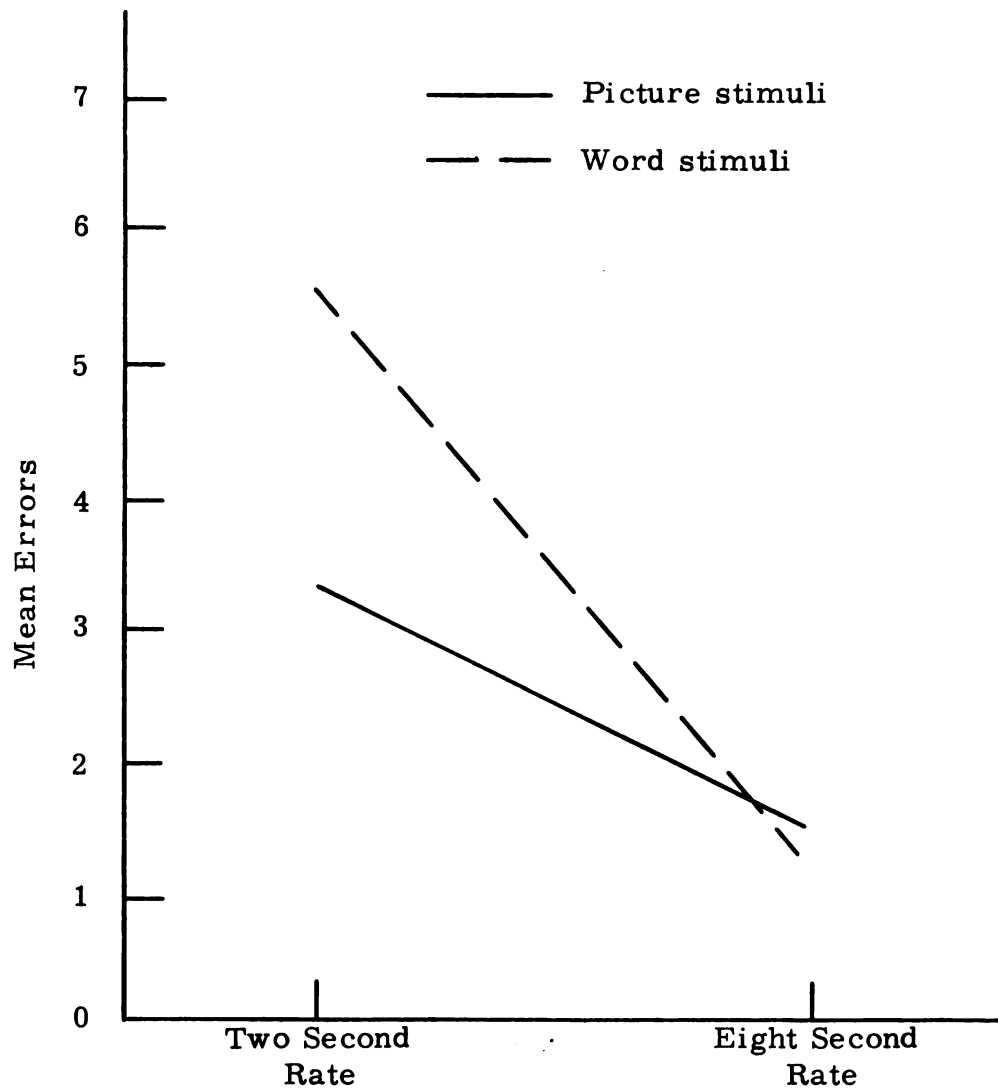


Fig. 3. -- Stimulus $\times$ presentation rate interaction: mean error scores.

interaction data. No experimental hypotheses were formulated with respect to the BC interaction data.

The significant ABC interaction ($F = 14.66$) is graphically presented in Figure 4. On picture stimulus lists, high imagery Ss performed better than low imagery Ss under both two and eight second presentation rates. Under the two second rate conditions, low imagery Ss made fewer word stimulus errors than high imagery Ss; however, under the eight second rate conditions, high and low imagery Ss did not differ on concrete word stimulus errors. The latter condition obtained primarily because of the greatly improved word stimulus performance of the high imagery Ss under the longer presentation time condition. Table 9 contains the Scheffé comparisons which pertain to the experimental hypotheses. Additional confidence intervals have been included for several comparisons for which hypotheses were not formulated but which bear on previously discussed two-way interactions. Discussion of the data is organized in relation to the relevant experimental hypotheses.

Hypothesis I

High imagery Ss will make fewer errors on the two second picture stimulus lists than on the two second concrete word stimulus lists.

Hypothesis I is accepted ($\hat{\psi} = 7.10$ to 4.30). For high imagery Ss, the superiority of picture versus word list learning

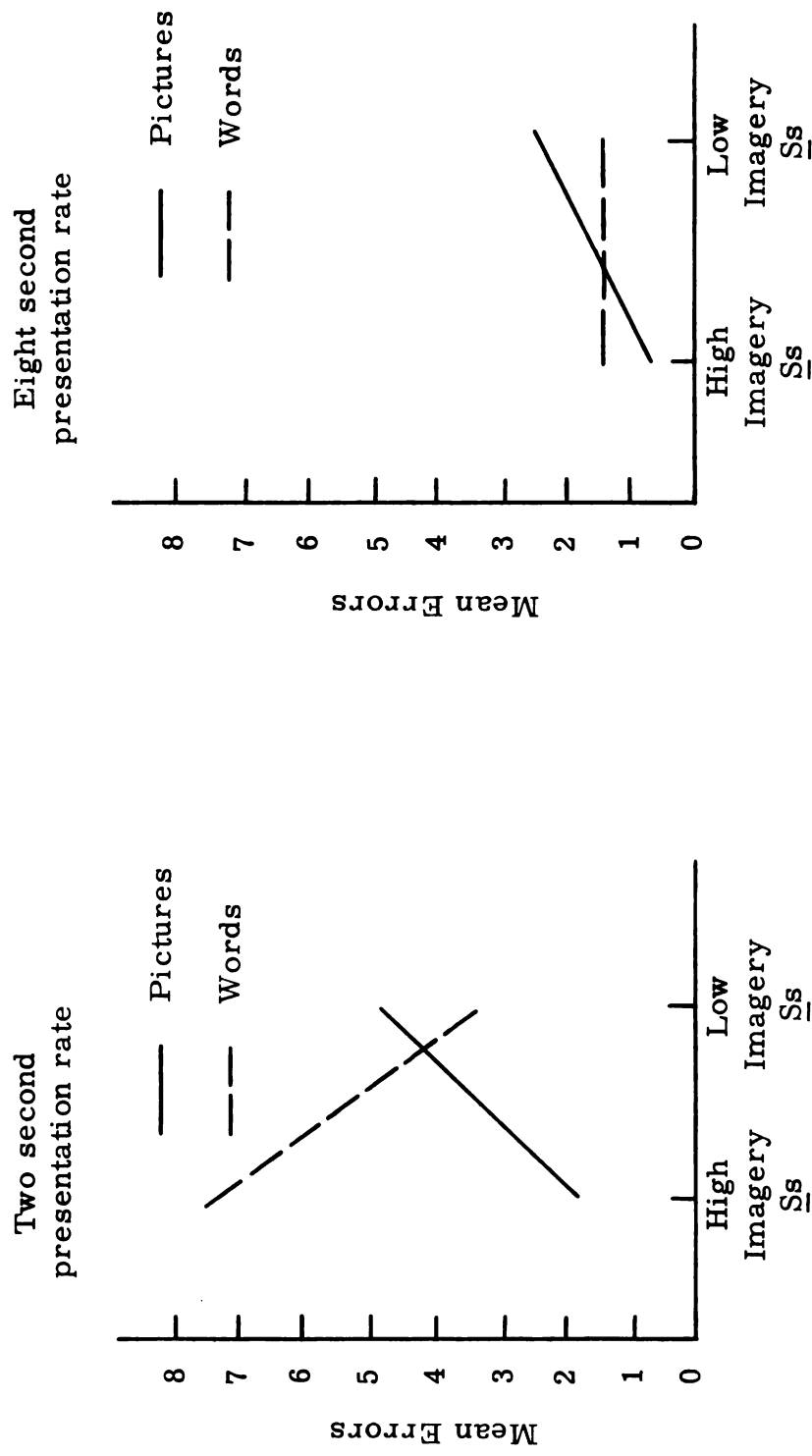


Fig. 4. -- Imagery $\times$ stimulus $\times$ presentation rate interaction: mean error scores.

TABLE 9

Scheffé Comparisons Calculated from the Significant
Imagery $\times$ Stimulus $\times$ Presentation Rate Interaction

	High imagery			Low imagery			
	2"W	8"P	8"W	2"P	2"W	8"P	8"W
HI2"P	7.10* 4.30	2.55 - .25		4.32* 1.52			
HI2"W			7.60* 4.80		5.45* 2.65		
HI8"P			2.05 - .75			3.02* .22	
HI8"W							1.41 -1.39
LI2"P					2.67 - .13	3.85* 1.05	
LI2"W							3.53* .73
LI8"P							2.35 - .55
LI8"W							

* $p < .05$

evidenced under the two second presentation rate became nonsignificant under the eight second presentation time rate ($\hat{\psi} = 2.05$ to $-.75$).

Hypothesis II

High imagery Ss will make fewer errors on the eight second concrete word stimulus lists than on the two second concrete word stimulus lists.

Hypothesis II is accepted ($\hat{\psi} = 7.60$ to 4.80). Given the longer presentation time, high imagery Ss greatly reduced their learning errors on the concrete word lists. The performance difference between two second and eight second concrete word conditions for high imagery Ss was the largest of the comparisons which were computed. Increased presentation time, apart from the stimuli dimension, cannot adequately account for the high imagers' performance. This was evidenced in the finding that high imagery Ss did not perform significantly better under the eight second rate conditions versus two second rate conditions when the stimuli were pictures ($\hat{\psi} = 2.55$ to $-.25$). Hypothesis III is rejected.

Hypothesis III

High imagery Ss will make fewer errors on the eight second picture stimulus lists than on the two second picture stimulus lists.

Hypothesis IV

Low imagery Ss will make fewer errors on the eight second concrete word stimulus lists than on the two second concrete word stimulus lists.

Hypothesis V

Low imagery Ss will make fewer errors on the eight second picture stimulus lists than on the two second picture stimulus lists.

Hypothesis IV is accepted ($\hat{\psi} = 3.53$ to $.73$). Hypothesis V is accepted ($\hat{\psi} = 3.85$ to 1.05). The directionally consistent findings of hypotheses IV and V would seem to clearly reflect that low imagers' performance improved accordingly when they were given more time in which to learn. The findings pertaining to Hypothesis VI were previously presented in this chapter. The superior performance of high imagery Ss versus low imagery Ss on picture stimulus lists was significant at both two and eight second presentation rates ($\hat{\psi} = 4.32$ to 1.52 , 3.02 to $.22$, respectively).

Hypothesis VII

Low imagery Ss will make fewer errors than high imagery Ss on the two second concrete word stimulus lists.

Hypothesis VII is accepted ($\hat{\psi} = 5.45$ to 2.65). However, under eight second presentation rates the performance of low imagery Ss failed to surpass that of high imagery Ss on concrete word lists ($\hat{\psi} = 1.41$ to -1.39).

Second Analysis

Table 10 contains the mean error scores and standard deviations for the two imagery groups under the two treatment conditions. The summary two factor analysis of variance is presented in Table 11.

TABLE 10
Mean Error Scores for High and Low Imagery Groups
under Concrete and Abstract Word
Stimulus Conditions

	Concrete words	Abstract words
High imagery <u>Ss</u> N = 40		
Mean	7.53	3.85
SD	6.14	2.02
Low imagery <u>Ss</u> N = 40		
Mean	3.48	8.23
SD	2.86	5.08

The main effect for imagery was not significant ($F = .05$). High and low imagery Ss did not differ in total learning performance. The main effect for stimuli (concrete versus abstract word lists) was also nonsignificant. The AB interaction (imagery $\times$ stimuli) met the stipulated significance requirement (.01). The significant

TABLE 11

Analysis of Variance for High and Low Imagery Ss
under Two Paired-Associate Stimulus Conditions
(Concrete Words versus Abstract Words)

Source of variance	SS	df	MS	F
Between subjects				
Imagery (A)	1.05	1	1.05	.05
Subjects	1584.89	78	20.32	
within groups				
Total	1585.94	79		
Within subjects				
Stimulus (B)	11.55	1	11.55	.65
A × B	709.81	1	709.81	40.08*
B × Subjects	1381.14	78	17.71	
within groups				
Total	2102.50	80		

* $p < .001$

interaction is presented graphically in Figure 5. The findings are presented in relation to the relevant experimental hypotheses.

Hypothesis VIII

High imagery Ss will make fewer errors on the two second abstract word stimulus list than on the two second concrete word stimulus lists.

Hypothesis VIII is accepted² ($\hat{\psi} = 5.23$ to 2.13).

²Confidence intervals for the second analysis were established with the required alpha level of .01.

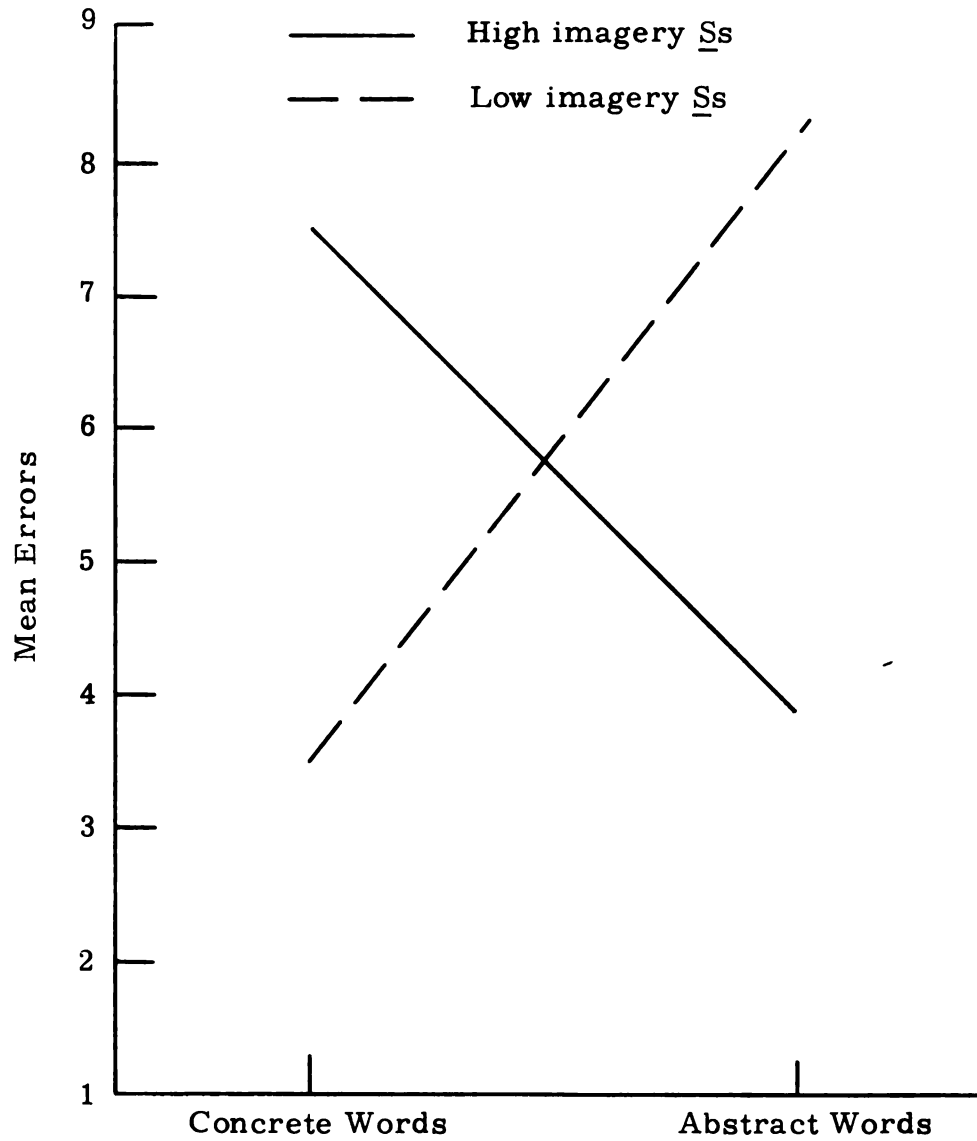


Fig. 5. --Imagery $\times$ stimulus interaction: mean error scores. Second analysis.

Hypothesis IX

Low imagery Ss will make fewer errors on the two second concrete word stimulus lists than on the two second abstract word list.

Hypothesis IX is accepted ($\hat{\psi} = 6.32$ to 3.22).

Hypothesis X

High imagery Ss will make fewer errors than low imagery Ss on the two second abstract word stimulus list.

Hypothesis X is accepted ($\hat{\psi} = 6.95$ to 2.85).

DISCUSSION

Nine of the ten experimental hypotheses were supported. High imagery Ss performed better on picture stimuli than on concrete word stimuli under the rapid presentation rate conditions. Given the longer presentation rate these differences did not obtain. These findings are consistent with the theoretical speculations concerning mediational processes for high imagery Ss. It was reasoned that the learning of pictorial material would lend itself most readily to the postulated high imagery style: the tendency to represent and store to-be-learned material in the form of mental pictures.

It was also reasoned that a stylistic tendency to recode words into pictures would be encouraged by the concrete word stimuli (high in picturability, by definition) used in the present study. Given a sufficient amount of time to engage in the recoding and decoding processes (from word stimuli to picture representation and from picture representation in memory to word stimuli), high imagery Ss performed as well under concrete word stimulus conditions as under picture conditions. However, when the time demands required more rapid productions, the performance of high imagery

Ss suffered dramatically. This decrement in performance is consistent with the assumption that recoding and decoding of material takes time. The time allowed for such processes in the present study, under the rapid presentation rate condition, was evidently insufficient. This interpretation of the results is consistent with previous reports (e.g., Yuille & Paivio, 1967), that imaginal mediation does require a relatively long period of time. However, the existent latency reports have been based on Ss whose individual mediational preferences and abilities have not been assessed. It is suspected that the imaginal latency times which have been reported in the literature would, to some extent, overestimate the time which Ss skilled in imagery would need to derive imaginal mediators. Observation of Ss in the present study yielded the impression that the eight second presentation and recall rates were excessive time allowances for the task demands. The results of the present study lend support to the contentions that usefulness of mediational technique (verbal or visual mediation) must be considered in relation to characteristics of the material to be learned (e.g., Paivio, Yuille, & Smythe, 1966) and the time provided for learning to take place (e.g., Bugelski, 1962; Yuille & Paivio, 1967) and the individual preferences and skills of the learner (Kuhlman, 1960; Stewart, 1965).

Of further interest to the present study was the question of modifiability of imagery use. It was thought that the rapid presentation of abstract word stimuli (low in rated picturability) would discourage high imagery Ss from exercising their preferred use of imagery abilities (that is, the representation of material in pictorial form). It was postulated that, under the given conditions, the most congruent modification of imagery use would be to relinquish attempts to recode the abstract words as pictures and, instead, to visualize the words directly, as words. The results strongly support the postulated modification. High imagery Ss performed much better on the abstract word stimulus list than on the concrete word stimulus lists.

It is possible that, instead of the inferred modification of imagery use, high imagery Ss abandoned the use of visualization entirely. However, the data do not suggest that high imagery Ss used either verbal mediators or mere repetition in the learning of abstract material. Had these Ss abandoned mediation techniques and resorted to simply repeating the abstract word-digit pairs, their performance should have been very poor. Repetition appears to be a singularly poor learning technique (e. g., Paivio & Yuille, 1967; Wood, 1967). If high imagery Ss had used verbal mediation techniques it becomes difficult to understand why these Ss performed

significantly better under the abstract word stimulus condition than did low imagery Ss. This reasoning is, of course, based on the assumption that low imagery Ss did, in fact, use verbal mediation techniques. As will be discussed, the data for low imagery Ss appear to warrant this assumption.

It should be noted that the present finding of superior learning of abstract versus concrete material (for high imagery Ss) is without precedent in the literature. Numerous investigators (e.g., Klein, Hale, Miller, & Stevenson, 1967; Paivio, 1963, 1965, 1967b) have reported that learning is superior when the material to be learned is concrete versus abstract. This reported superiority has been obtained (with no exceptions known to this investigator) with Ss for whom imagery skills have not been assessed. Paivio (1966) reported that imagery mediational set latency was significantly lengthened as items increased in abstractness. However, it should be remembered that Ss in this study were instructed to form pictures in their heads; they were not instructed to use visualization in whatever manner would be helpful.

When the high and low imagery group scores from the present study are combined, a trend emerges which is consistent with the larger body of literature: for the total group of Ss, concrete words were learned with fewer errors than abstract words.

The present study, of course, needs to be replicated, perhaps especially with respect to the hypothesized, albeit "deviant," abstract versus concrete word stimulus finding for high imagery Ss.

Low imagery Ss performed nonsignificantly better on concrete word versus picture stimulus lists under both the two and eight second rate conditions. They performed significantly better on concrete word stimulus lists versus the abstract word stimulus list. Stewart (1965) also found a nonsignificant difference between picture and word learning for her low imagery Ss (investigated at a two second rate only). However, she found that pictures were learned slightly better than words. The findings in the present study are consistent with the assumption that low imagery Ss make use of verbal mediation techniques. It is understandable that differences between picture and concrete word stimulus learning would not be pronounced; verbal labels are readily available for the pictorial stimuli used. Furthermore, there is no reason to assume that low imagery Ss cannot and do not supplement their verbal mediation techniques with some use of imagery.

The superior performance of low imagery Ss on concrete words versus abstract words is also consistent with the assumption that these Ss use verbal mediation techniques. Paivio (1966)

reported a correlation of $-.46$ between rated item imagery and verbal reaction time (time elapsed before Ss reported finding an appropriate verbal mediator for the items). It is suspected that the use of digits as response members in the present study contributed to the low imagers' differential performance on concrete versus abstract words. Since concrete words refer to "countable" objects, it was probably easier to directly incorporate the response member into the mediational forms used with these concrete stimuli.

High imagery Ss performed significantly better than low imagery Ss on picture stimulus lists at both two and eight second presentation rates. High imagers also performed significantly better than low imagers under the abstract word list condition. Low imagers performed better than high imagers on concrete word stimulus lists at the two second presentation rate. As expected, under the eight second presentation rate (versus the two second condition), with concrete word stimuli, the high imagery Ss made a proportionately greater improvement in their performance than did low imagery Ss. Performance differences between the imagery groups were not significant under the eight second concrete word condition. These results again coincide with the interpretations that high imagery Ss make use of visualization skills in their learning of associations while low imagery Ss make use of verbal mediation skills.

All Ss took advantage of the longer learning and recall time conditions and improved their performances accordingly. However, the disproportionate gain evidenced by high imagery Ss (from two second concrete words to eight second concrete words) is consistent with evidence (e.g., Yuille & Paivio, 1967) that imaginal mediation consumes a considerable amount of time. This mediational delay is assumed to reflect the necessary coding and decoding processes of transferring stimulus words into pictures and inclusion of the response elements in the pictorial representation, then, on test trials, retrieval of the pictorial image and decoding this image back into word form and making a response. Given imaginal mediation as a preferred style and sufficient time with incongruent stimuli (i.e., words), imagery use emerges as an efficient learning device. Given sufficient time and congruent stimuli, high imagery Ss evidenced the most proficient learning obtained in the present study.

It might be reasoned that compared to the more rapid presentation rate, low imagery Ss would have made a proportionately greater gain (versus high imagers) when given more time to learn stimuli which were incongruent for them (i.e., pictures). This proportionately greater gain did not obtain. In fact this proportional gain (eight second pictures versus two second pictures for low imagers) was the smallest improvement that occurred between the

eight second and two second rate conditions. Since it must be assumed that, given incongruent stimuli, verbal mediation must also involve recoding and decoding processes, it is difficult to understand why low imagers did not make more efficient use of the longer learning and recall times under the picture stimulus conditions. At this time, in lieu of further research, it can only be reasoned that, since verbal labels are readily available for pictorial stimuli, low imagers were already performing near their peak performance on pictorial stimuli even under the rapid rate conditions. Incongruency of stimuli seems to be a more influential factor for imaginal mediation than for verbal mediation.

The results of the present study, in conjunction with previous findings (e.g., Stewart, 1965), in no way suggest that the obtained performance differences between imagery groups can be attributed to "intelligence" or overall learning ability differences. Imagery groups did not differ in overall learning on the PA lists. CQT scores, available for 63 of the 80 Ss, also failed to discriminate between the imagery groups. At first sight the lack of differences between imagery Ss on the Verbal section of the CQT seems somewhat surprising. However, clearly high imagery Ss have been able to come to terms with our highly verbal educational world or they would not have even been available for scrutiny among the

sample of college Ss studied. Also given our present state of knowledge, it is probably more appropriate to address our thinking to mediational preferences instead of skills. Of course we do expect style to reflect both preference and ability. It is this investigator's suspicion that full scale Wechsler testing would offer a more definitive answer to the question of differential abilities which could contribute to, but be obscured by, "equal" overall intelligence scores.

The PA data from the present study can be readily conceptualized in terms of mediational styles. It is difficult to derive an alternate conceptualization. As intended, the present study does seem to have addressed itself to imaginal differences. This outcome is scarcely less amazing than it is encouraging. The correlation between the two imagery-defining tasks (Space Relations Test and Flags Test) accounts for only 29 per cent of the test variance. Nonetheless, the present study falls in line with those of Kuhlman (1960) and Stewart (1965); imagery differences do seem to be accurately reflected in objective test scores. It appears that one of the greatest handicaps which plagued previous investigators interested in imagery differences has been overcome. No longer are we entirely dependent upon the Ss' introspective reports from which to obtain our estimates of imagery ability and use.

For female Ss, the magnitude of the correlation between the Test of Mechanical Comprehension and the imagery-defining measures was larger than expected. To attempt to attribute high and low imagers' differential picture-word stimulus performances to "mechanical ability" differences between the Ss does not seem to make much sense. Taken from the other vantage point, it does appear more logical that imagery ability could contribute to differential performance on the Test of Mechanical Comprehension; imagery use could be helpful, for example, in permitting the Ss to actually execute for themselves (via pictures) the implied movements on many of the mechanical comprehension items. Also, it is probably not without relevance that the items on the Test of Mechanical Comprehension are pictures.

Implications and Suggestions for Future Research

Further work needs to be conducted in order to isolate the best objective imagery-defining task or combination of tasks. Kulhman (1960) used the Flags Test as her imagery-defining task. Both Stewart (1965) and the present investigator used a combined score based on the Flags Test and the Space Relations Test. Ernest and Paivio (1969) used a combined score based on the Space Relations Test, the revised Minnesota Paper Form Board (MPFB) and the

MPFB Questionnaire. It is this investigator's impression that the Space Relations Test requires a more demanding use of imagery than does the Flags Test. Ideally, each of the tests which have been used, as well as additional "face validity" instruments, should be evaluated for their predictive power in relation to relevant learning situations (such as differential picture-word stimulus performances).

The results of the present study accord quite well with theoretical considerations and with empirical results involving (e.g., Stewart, 1965) data gathered by traditional techniques. The group procedure used for collecting the PA data in the present study has many practical advantages to recommend it. Theoretically (if it had been possible to avoid scheduling difficulties due to final examinations which were given at the time the present study was being conducted), only four group PA sessions (corresponding to the list order sequences) were necessary in order to obtain data on the 80 Ss. Fewer than three hours of testing time is contrasted with slightly more than 53 hours had Ss been tested individually. This latter figure is an estimate, of course, but the point remains that the time savings is substantial. Ernest and Paivio (1969) have reported their presentation of PA material via 35-mm slides to two Ss at a time. To this investigator's knowledge, no reports of studies exist in which larger numbers of Ss have been presented

with PA material via movie film. Regardless of method of presentation, the laborious procedures involved in constructing PA lists in both picture and word form with appropriate sequence variations, again pragmatically, dictate the use of the materials in several experiments. The expense involved in the filming procedure must be weighed against the savings in time; an investigator whose interests in the area could be satisfied with one experiment would probably do well to confine his methodological data gathering procedures to the traditional memory drum technique.

Quite apart from the practical considerations discussed above, the filming of PA material for group presentation raises several interesting issues. This investigator suggests that the group testing procedure used in the present study may yield learning scores which are less confounded by other factors, namely anxiety and experimenter bias effects, than does the traditional memory drum procedure. The traditional method of data gathering involves the presence of the investigator and a solitary S. On each test trial the S gives his responses orally to the experimenter who, in turn, presumably knows but does not give the S (intentional) feedback on the correctness or incorrectness of his responses. This lack of feedback is modified only when the S gives a correct trial, at which point, the E communicates this accomplishment by

terminating the experiment for the S. A large component of what is being measured may well be a mixture of the E's ability to communicate his hypotheses or otherwise influence his results and the S's anxiety arousal in the face of a potentially evaluative authority who withholds information! Group testing situations are certainly not free from anxiety factors (see, for example, Innes & Sambrooks, 1969), but the experimenter bias effect should be minimized, at least to the extent that differential performance is expected of Ss attending the same group session. A beginning clarification of the issues should emerge from research which compares the two data gathering techniques and also includes anxiety measures on the participating Ss.

Procedural variations more specifically relevant to imagery differences would include the comparison of to-be-learned verbal material in terms of visual presentation (the procedure used in the present study) versus auditory presentation. This variation would hold implications for applied concerns since, after grade school at least, we depend heavily upon the oral method of imparting information.

The eight second presentation and recall times were selected, on the basis of previous evidence (e.g., Yuille & Paivio, 1967), in order to insure an adequate mediational time condition.

As mentioned previously, observation of Ss yielded the impression that the eight second rate was longer than necessary; this E would suggest that five seconds would be quite sufficient. The question of the distribution of mediational time is of considerable theoretical interest. The processes of recoding (encoding) and decoding may not entail equal amounts of time. This investigator would postulate that high imagery Ss need more time to decode than to encode material. Since "thinking in pictures" is assumed to be the high imager's preferred style, the encoding of concrete verbal material into pictorial form should occur fairly rapidly. However, it should take the high imager comparatively longer to decode his pictorial association and retrieve the verbal components. Low imagers, using verbal mediational techniques, should need more equal amounts of time in which to perform their encoding and decoding processes. These speculations would be easily testable by varying presentation and recall rates in a PA design.

Another interesting time variation presents itself with respect to high imagers' performance under the abstract word stimulus condition. Given the high imagers' inferred preference for recoding words into pictures, if longer time rates were provided (e.g., five seconds), these Ss might be tempted to exercise this preference. However, the stimulus conditions of abstractness,

even under these extended time conditions, are not thought to lend themselves to a pictorial use of imagery. One would be tempted to hypothesize that high imagery Ss would perform more poorly on abstract word pairs under five second conditions than two second conditions.

Imagery research needs to be extended in several directions before we can begin to assess the practical implications. Researchers have just begun to address themselves to the developmental aspects of the role of imagery in learning. The majority of evidence available to date indicates that ". . . a preference for and a capacity to make effective use of visual representation and storage develops later than is the case for verbal modes of representing and storing information" (Rohwer, 1969, p. 42). These results are at variance both with one formal theory (Bruner, 1966) and much informal armchair theorizing which holds that imaginal forms of storage develop earlier than verbal. An immediate speculation emerges from these findings. Perhaps some of our educational techniques need to be stood on head; we might do well to increase our pictorial representations of material with increasing age--not the reverse. Perhaps, even more importantly, we need to address ourselves to the assessment of an individual's learning preferences and skills and take advantage of these tendencies via

our instructional procedures. Lastly, we need to approach the intriguing and unexplored possibilities of teaching people to develop and make use of both visual and verbal methods of representing and storing information, as the situation warrants.

In a slightly different vein, approaching the investigator's therapeutic interests, studies need to be conducted in which the affective and anxiety-evoking nature of the stimuli are varied along both visual and verbal dimensions, and the impact of these variables assessed in relation to high and low imagery. Such experiments could reveal differential coping and defensive techniques used by high and low imagers.

We also need to investigate pairs of Ss (high imagery-high imagery, low imagery-low imagery and high imagery-low imagery Ss) in problem-solving task situations as a beginning attempt to simulate a therapeutic interaction. It may well be that miscommunications are most prevalent among "mixed" pairs. At the more extreme end of the continuum, there are probably those high imagers for whom virtually all subjective or internal states and processes (thoughts, feelings, fantasies, etc.) are experienced in pictorial form. It is not difficult to imagine some of the frustrations such persons could experience: trying to study a verbal text and having mental pictures, with all their possible embellishments, intrude

sentence to sentence, word to word, or trying to find the words by which to communicate with someone else what they can't see--the pictures from which you are trying to talk.

With respect to more pathological phenomena, studies in the area might reveal that visual and auditory hallucinations represent exacerbations of normal stylistic imagery differences. It is interesting to note in this vein that schizophrenic Ss have long been described as concretistic (e.g., Goldstein, 1959). In addition to and apart from a deterioration of skills, such findings may well be indicative of some correlates of a high imagery style.

SUMMARY

The present study addressed itself to the investigation of imagery differences in the learning of pictorial and word stimulus-digit paired-associate items. High and low imagery groups were defined by a combined standard score distribution involving the Flags Test and the Space Relations Test. The imagery-defining tasks were administered during the first experimental session; PA lists were administered in a second experimental session. Volunteer Ss were obtained from Michigan State University, Lansing Community College and a high school honors program. Complete data were collected from 80 female Ss.

The Ss learned five PA lists: two concrete stimulus lists administered at two second rates, two concrete stimulus lists administered at eight second rates, and an abstract list administered at two second rates. The concrete lists consisted of words rated high on imagery, concreteness and meaningfulness; the abstract words were high in meaningfulness and low in rated imagery and concreteness values. All lists consisted of high frequency words. The four concrete lists were equated for imagery, concreteness and

meaningfulness values. The concrete stimulus lists were each symbolized in both picture and word form. The abstract list stimulus members were always words. Response members for each list were the digits two through nine. Each S learned a two second concrete list with pictures as stimulus members, a two second concrete word stimulus list, an eight second picture stimulus list, an eight second concrete word stimulus list and the two second abstract word list. There were eight paired items per list. List sequences were presented in two different orders. Within-list randomizations were used across all learning and test trials.

The PA lists were filmed and presented to groups of Ss. Four different film strips were used (corresponding to list order sequences and picture-word stimulus variations). Subjects were given five learning trials and five test trials on each list. Learning and test trials were alternated. The learning criterion was total number of errors across the five trials. Subjects gave written responses in the booklets provided.

Nine of the ten experimental hypotheses were supported. High imagery Ss performed better on picture stimulus lists; low imagery Ss performed better on concrete word stimulus lists, and high imagery Ss performed better on the abstract word list. Both subject groups performed better under the eight second versus the

two second presentation times; however, high imagery Ss improved more from the shorter to the longer presentation rates, so that, under the eight second rate conditions, high imagers performed as well as low imagers on the concrete word stimulus lists.

The results were discussed in relation to inferred imagery and verbal mediation styles. No evidence was obtained to indicate that the high and low imagery groups differ in intelligence test scores or overall learning ability. Correlational data were interpreted as indicating that imagery ability may play a facilitating role in mechanical comprehension. Implications of the results and suggestions for future research were presented.

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APPENDICES

APPENDIX A

PAIRED-ASSOCIATE LISTS

APPENDIX A

PAIRED-ASSOCIATE LISTS

Concrete List I

book	- 2
ear	- 8
fish	- 9
key	- 6
leaf	- 3
pear	- 4
pencil	- 7
watch	- 5

Concrete List II

apple	- 8
cane	- 5
cup	- 4
eye	- 2
fly	- 6
glasses	- 3
house	- 9
shoe	- 7

Concrete List III

arm	- 7
car	- 4
mountain	- 2
boy	- 9
table	- 5
door	- 8
bottle	- 6
flag	- 3

Concrete List IV

tree	- 4
bird	- 9
diamond	- 3
ship	- 7
fire	- 2
potato	- 6
flower	- 8
coin	- 5

Abstract List V

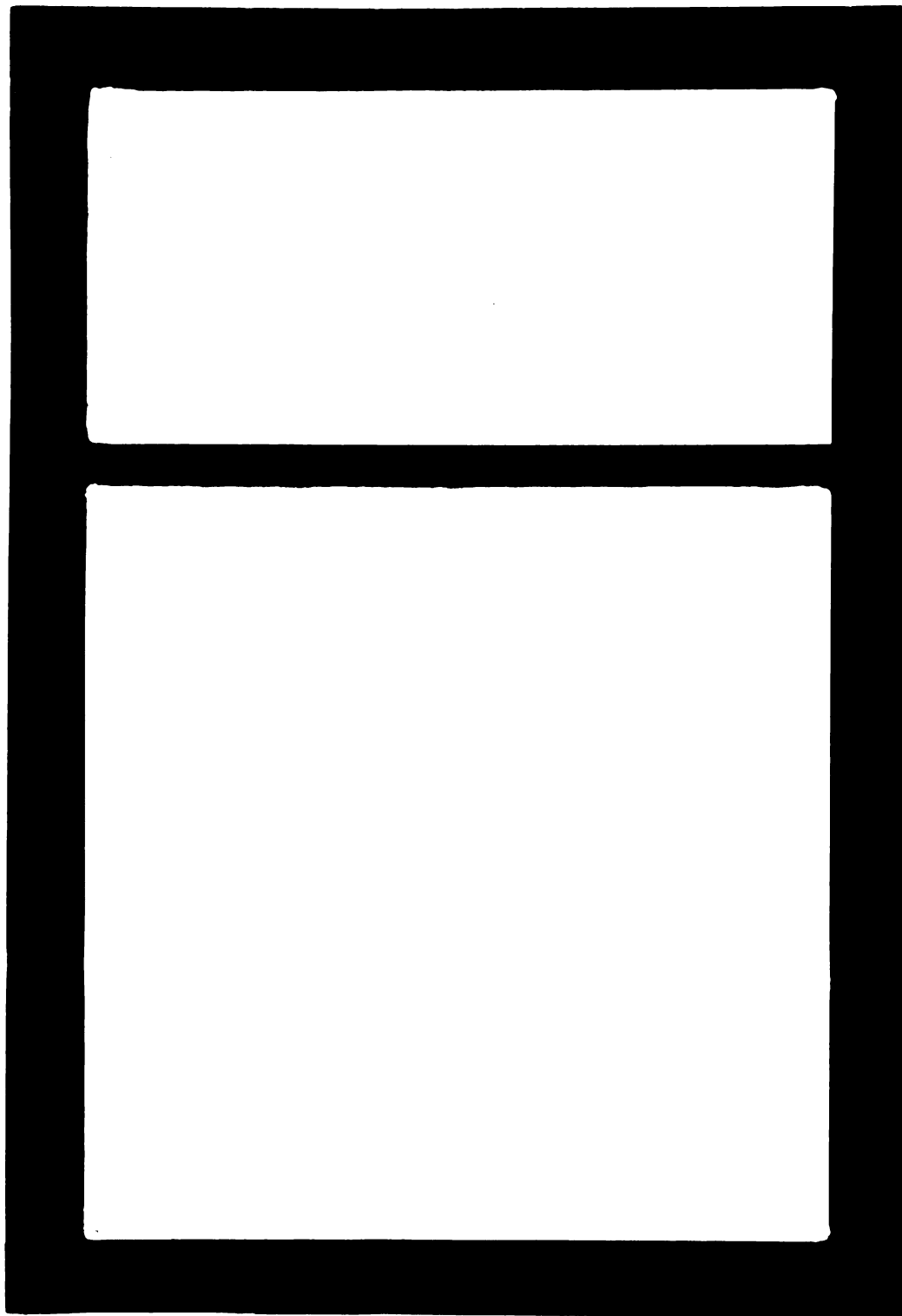
soul	- 3
position	- 6
justice	- 8
knowledge	- 5
development	- 2
history	- 9
evidence	- 7
answer	- 4

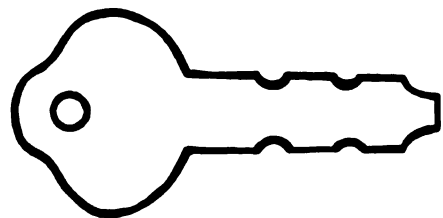
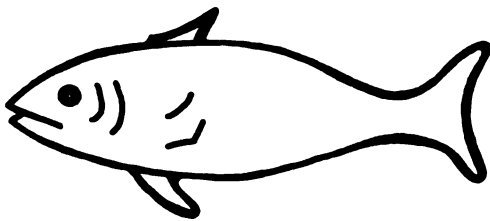
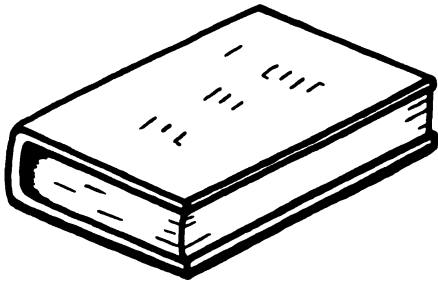
APPENDIX B

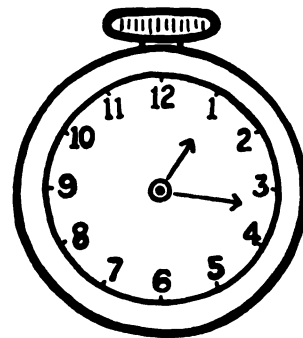
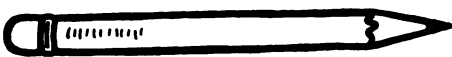
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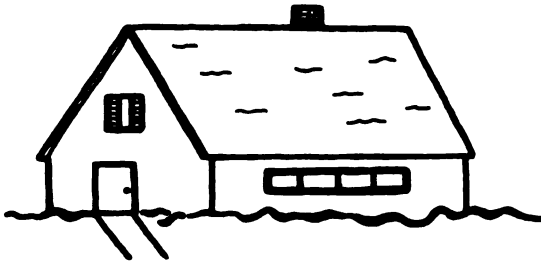
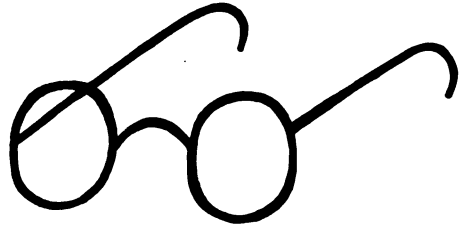
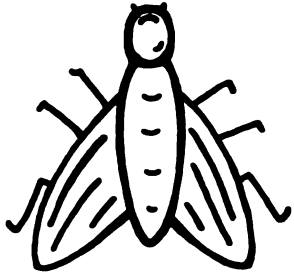
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Pictures Reduced 50 Percent**

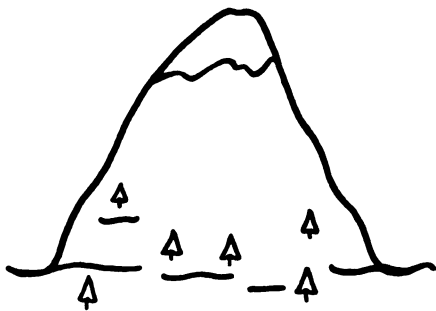
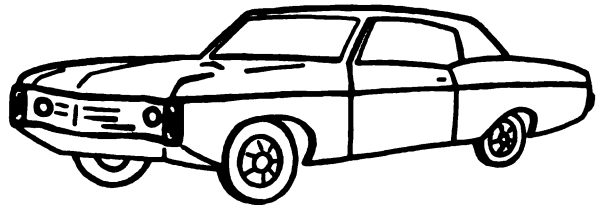
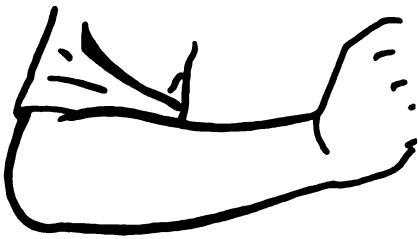
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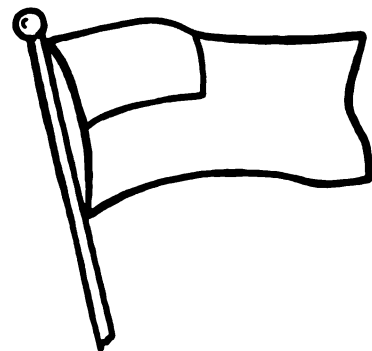
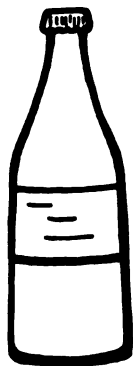
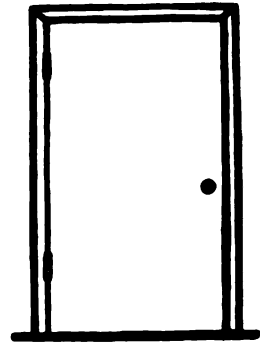
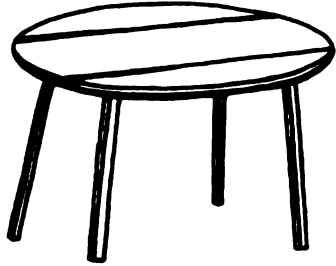


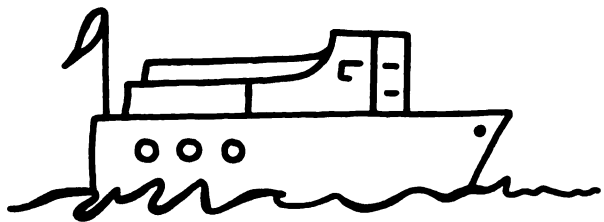
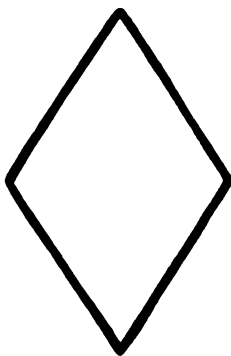
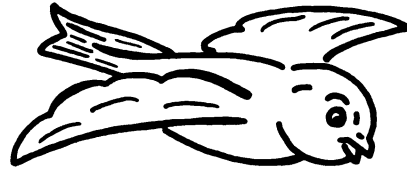
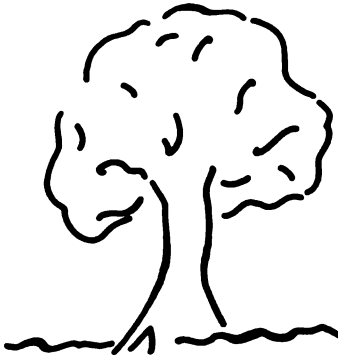
Concrete List I

Concrete List I

Concrete List II

Concrete List III

Concrete List III

Concrete List IV

APPENDIX C

WITHIN-LIST RANDOMIZATION ORDERS FOR LEARNING AND TEST TRIALS: PAIRED-ASSOCIATE LISTS

APPENDIX C

WITHIN-LIST RANDOMIZATION ORDERS FOR LEARNING AND TEST TRIALS: PAIRED-ASSOCIATE LISTS

	Learning Trials				
	1	2	3	4	5
Items	1	2	3	4	5
	2	5	1	6	3
	3	8	5	2	7
	4	3	7	8	1
	5	6	2	1	8
	6	1	4	7	2
	7	4	8	3	6
	8	7	6	5	4
	Test Trials				
	5	4	1	2	3

APPENDIX D

SUBJECTS' TEST SCORES AND PA ERROR SCORES

APPENDIX D

Subjects' Test Scores and PA Error Scores

Flags Test	Space Relations Test	Combined Standard Score	Test of Mechanical Compre- hension	College Qualification Test			Paired-Associate Lists (errors)				
				V	N	T	2"P	8"P	2"W	8"W	AW
124	85	76	43	68	15	133	5	2	3	3	8
116	89	75	48	45	25	113	0	0	18	0	1
114	91	75	37	58	26	124	1	1	10	3	2
100	90	70	47	73	42	174	1	0	5	2	2
112	76	69	40	44	27	110	1	0	2	1	7
90	94	69	30	58	38	143	1	0	17	2	8
88	90	67	43	-	-	-	4	1	24	0	4
90	86	66	57	-	-	-	0	1	10	1	4
82	92	66	36	-	-	-	0	0	7	2	3
84	90	65	47	50	21	116	1	0	8	0	1
93	82	65	47	-	-	-	1	0	6	4	4
114	61	64	32	69	21	143	1	2	3	2	2
93	79	64	35	64	30	147	0	0	13	0	5
72	97	64	44	63	34	154	0	2	2	2	3
98	68	62	27	56	41	147	2	0	1	0	4
85	80	62	35	-	-	-	3	1	8	0	7
77	81	60	41	53	30	129	2	0	3	0	5
102	54	58	26	50	22	111	2	2	15	0	4
76	76	58	33	66	22	132	0	0	5	1	6
73	78	57	32	43	40	129	1	1	12	3	2

APPENDIX D (Continued)

Flags Test	Space Relations Test	Combined Standard Score	Test of Mechanical Compre- hension	College Qualification Test			Paired -Associate Lists (errors)				
				V	N	T	2"P	8"P	2"W	8"W	AW
82	69	57	31	53	30	127	4	0	3	1	3
66	82	57	41	67	41	160	1	3	0	0	5
100	52	56	27	65	37	156	4	1	2	2	3
69	78	56	27	42	11	91	3	1	6	1	4
78	68	55	34	-	-	-	2	1	2	5	1
73	72	55	32	45	29	123	0	0	1	1	4
52	87	54	27	51	24	114	2	1	3	2	2
71	69	54	29	71	30	156	3	0	21	0	6
80	62	54	29	56	28	132	1	0	5	0	5
81	59	53	18	44	38	116	5	0	6	0	3
85	57	53	38	51	38	134	1	2	16	2	2
64	74	53	44	74	48	177	1	1	4	3	3
67	70	53	21	45	41	127	3	1	4	3	3
78	59	52	24	39	21	89	5	0	5	0	8
51	83	52	27	57	36	146	1	0	5	2	2
52	82	52	33	53	31	132	2	1	20	1	3
51	83	52	23	-	-	-	2	0	12	3	1
80	54	51	29	40	19	88	4	0	3	0	7
59	72	51	23	57	28	132	2	0	4	0	4
57	73	51	38	46	44	137	1	2	7	1	3

High Imagery Ss, N = 40

APPENDIX D (Continued)

Flags Test	Space Relations Test	Combined Standard Score	Test of Mechanical Comprehension	College Qualification Test			Paired-Associate Lists (errors)				
				V	N	T	2"P	8"P	2"W	8"W	AW
83	50	50	23	49	31	121	6	4	9	6	16
58	71	50	24	-	-	-	2	2	5	0	4
65	63	49	21	-	-	-	1	1	3	2	9
58	68	49	24	54	17	117	5	3	8	2	8
80	48	48	35	67	30	144	2	0	4	0	11
86	41	48	34	51	31	130	1	6	3	2	10
74	52	48	33	67	46	174	2	2	4	3	5
66	56	47	19	-	-	-	3	1	2	0	10
64	58	47	15	-	-	-	2	0	0	0	6
61	59	47	28	59	47	163	3	2	4	2	3
42	75	47	29	64	29	138	4	3	12	3	7
44	79	46	38	62	40	155	0	0	8	1	3
43	72	46	38	68	27	149	4	0	1	1	5
64	56	46	26	-	-	-	5	3	3	0	16
61	58	46	21	-	-	-	3	5	5	2	18
52	65	46	38	-	-	-	6	0	0	0	14
64	51	45	24	53	28	129	4	5	7	2	20
48	63	44	29	-	-	-	6	2	2	0	3
55	53	43	11	-	-	-	14	0	1	1	7
66	45	43	37	65	35	158	4	7	2	3	9

