DOCUMENT RESUME

ED 095 519 CS 001 329

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| TITLE | Is There a Separate Visual Iconic Memory System? Final Report. |
| INSTITUTION | Indiana Univ., Bloomington. Audio-Visual Center. |
| SPONS AGENCY | National Inst. of Education (DHEW), Washington, D.C. Office of Research Grants. |
| BUREAU NO | BR-3-0826-FR |
| PUB DATE | Aug 74 |
| GRANT | NE-G-00-3-0107 |
| NOTE | 54p. |
| EDRS PRICE | MF-$0.75 HC-$3.15 PLUS POSTAGE |
| DESCRIPTORS | Attention; Cognitive Processes; College Students; *Educational Research; Learning Processes; *Memory; Recall (Psychological); *Recognition; *Retention; *Visualization |

ABSTRACT

The purpose of these studies was to provide evidence to support either the dual-coding hypothesis or the single-system hypothesis of human memory. In one experiment, college subjects were shown a mixed series of words and pictures either while simultaneously engaged in shadowing (repeating aloud) a prose passage presented via earphones or while free of such distractions. On a multiple-choice recognition test, it was found that the verbal shadowing task interfered with word performance but failed to affect pictorial recognition memory, indicating that verbal information and pictorial information may be processed independently in parallel recognition memory systems. In a similar experiment recall rather than recognition was the dependent measure. While the usual pictorial superiority was found, the verbal shadowing task interfered with picture as well as word retention, suggesting that in memory tasks where verbal reports are required, subjects characteristically attempt to translate easily labelable pictorial information into verbal terms during the encoding phase. Thus there does appear to be a separate visual iconic memory system, but it normally operates in total independence of the verbal system only when the anticipated use of information is nonverbal in character. (Author/WR)

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and
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## Abstract

Evidence was sought to support either the dual-coding hypothesis or single-system hypotheses of human memory. In one experiment, Ss were shown a mixed series of words and pictures either (1) while simultaneously engaged in shadowing (repeating aloud) a prose passage presented via earphones or (2) free of such distraction. On a multiple-choice recognition test, it was found that the verbal shadowing task interfered with word performance but failed to affect pictorial recognition memory, indicating that verbal information and pictorial information may be processed independently in parallel recognition memory systems. In another similar experiment, recall rather than recognition was the dependent measure. While the usual pictorial superiority was found, the verbal shadowing task interfered with picture as well as word retention, suggesting that in memory tasks where verbal reports are required, Ss characteristically attempt to translate easily labelable pictorial information into verbal terms during the encoding phase. Thus there does appear to be a separate visual iconic memory system, but it normally operates in total independence of the verbal system only when the anticipated use of information is nonverbal in character.

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## INTRODUCTION

When pictures are compared to words as stimuli in experimental learning tasks, significant differences are usually found. Performance on tasks involving pictures is almost always superior to that on tasks involving words. Pictures result in better performance in recognition memory tasks (e.g., Shepard, 1967; Snodgrass, Volvovitz and Walfish, 1972; Standing, 1973), in free recall tasks (e.g., Paivio, Rogers and Smythe, 1968; Kaplan, Kaplan and Sampson, 1968; Sampson, 1970), and as stimulus items in paired-associate learning tasks (e.g., Paivio and Yarmey, 1966; Jenkins, 1968; Wicker, 1970). On the other hand, under some conditions involving sequential memory, words result in better performance (e.g., Paivio and Csapo, 1969, 1971; Del Castillo and Gumenik, 1972).

Researchers are discovering qualitative as well as quantitative differences in the ways in which pictures and words are processed by the human information system. For example, while it is well known that memory for words is highly dependent upon opportunities for rehearsal, it appears that pictures are not ordinarily rehearsed but are recorded in memory more or less instantaneously (e.g., Shaffer and Shiffrin, 1972; Hintzman and Rogers, 1973; Cohen, 1973). Such research has led to divergent hypotheses concerning the mechanisms by which pictures and words are encoded, stored and retrieved in memory.

### "Single-System" Hypotheses

One tendency is to assert that the processing of pictorial stimuli can be accounted for by the same memory mechanisms that are used to describe the processing of verbal information.

The most straightforward of these explanations is the verbal loop hypothesis. Glanzer and Clark (1963a, 1963b, 1964) propose that people covertly translate pictorial information into a series of words, store this verbalization, and retrieve from it when a response is required. The type of evidence offered by these authors and others (e.g., Lantz and Steffre, 1964; Smith and Larson, 1970) in support of the verbal loop hypothesis is that recognition accuracy of visual displays such as color chips is related to subjects' verbal descriptions of these displays and to the effectiveness of these descriptions in communicating accurately.

As another example, picture-word differences in discrimination learning and recognition memory have been explained by a mechanism that operates in the same manner for both words and pictures -- frequency theory. In discrimination learning, previously seen "old" stimuli are to be identified when presented with "new" stimuli added as distractors. Frequency theory states that it is the unequal frequency of occurrence of the new and old stimuli that is largely responsible for the subject's ability to discriminate the old item. Ghatala, Levin, and Wilder (1973) suggest that while the words used as stimuli in discrimination experiments have been previously encountered by the subject, the pictures used are almost certainly unique in the subject's experience and hence constitute more stable subjective frequency units. In an experiment in which the apparent frequencies of words and pictures were equated (Levin, Ghatala and Wilder, 1974), the usual superiority of pictures was eliminated.

Other researchers have emphasized similarities between apparent underlying processes used in memory for sentences and pictures. Benjafield and Doan (1971) assert that comparative sentences (e.g., A is larger than B) are encoded in the same way that corresponding pictures (e.g., a drawing showing two pencils, one sharper than the other) are encoded. Similarly, Clark and Chase (1972) in a study of how people compare sentences against pictures (e.g., the sentence "Star isn't above plus" and the picture "$\overset{*}{+}$") offer the proposition that a common "interpretive" system is used for both linguistic and perceptual stimuli of this kind. They argue that "...psychologists must come to regard certain thought processes not simply as 'verbal' or 'perceptual' in nature, but as 'cognitive.'" (p. 515)

The most complex and well articulated approach of this kind is a model developed by Anderson and Bower (1973) in which both linguistic and perceptual information are handled by a single conceptual-propositional system. This system, called HAM for human associative memory, "...supposes that knowledge -- even knowledge that is derived from pictures or that is used in generating images -- is always represented in the form of abstract propositions about properties of objects and relations between objects." (p. 452) Interestingly, Bower has in the past been heavily involved in research dealing with mental imagery and quite recently (Bower, 1972) subscribed to the notion of an imaginal as well as a verbal memory system. This dramatic reversal in viewpoint by a psychologist of Bower's stature should give pause to those who unhesitatingly accept multiple system memory models.

## The Dual-Coding Hypothesis

The dual-coding hypothesis (Paivio, 1971) proposes two separate memory systems, one for verbal symbolic processes and another for nonverbal imagery processes. The two systems may operate independently, but they are also richly interconnected and often operate in conjunction with each other. Thus, while linguistic information may be handled solely by the verbal system, words may also evoke mental images, thus activating the imaginal system. Similarly, pictures in addition to iconic encoding can be labeled or can otherwise arouse the verbal system.

While the dual-coding hypothesis has additional implications, the aspect of the model which is of concern here is the notion that more than one system is involved. What follows is a brief review of the research that tends to support the plausibility of two memory systems --

each with the capability for independent operation.

One class of such evidence comes from neurophysiological research. Considerable evidence has been produced to indicate that the left and right cerebral hemispheres function differentially with respect to verbal and imaginal processes (e.g., Sperry, 1961; Milner, 1970; Geffen, Bradshaw and Wallace, 1971). The left hemisphere dominates for tasks which involve abstract thinking and linguistic processes while the right hemisphere dominates for perceptual and nonverbal functions. Researchers such as Seamon and Gazzaniga (1973) argue that these brain laterality effects suggest separate information systems. In related research, Galin and Ornstein (1972) found that subjects who were engaged in verbal cognitive operations displayed distinctly different EEG patterns from subjects engaged in spatial cognitive operations.

A variety of behavioral research appears to support the dual-system hypothesis. Bahrick and Boucher (1968) found that verbal recall of the word label for a simple drawing was unrelated to the probability of correct visual recognition of the drawing. In a subsequent study, Bahrick and Bahrick (1971) found no correlation between performance on visual and verbal recognition tests of previously seen drawings. Cermak (1971) provided evidence to support the existence of an independent visual iconic memory system by demonstrating that subjects were able to recognize free-form nonsense figures under a condition which would seem to preclude any verbal coding of the visual information. Similarly, Paivio and Csapo (1969) demonstrated memory for pictures which were presented at rates too rapid to allow for verbal coding. Nelson and Brooks (1973) showed that while paired associate learning was inhibited when word pairs were phonetically similar, there was no difference in the learning of phonetically similar and phonetically dissimilar picture pairs, implying that the pictorial code functioned independently of the verbal label code. In a recognition test of previously seen words and easily labeled pictures, Snodgrass, Wasser, Finkelstein and Goldberg (1974) showed that subjects were later able to identify whether a concept had been presented as a word or a picture, suggesting that the two were encoded and stored differently.

Another group of behavioral researchers (den Heyer and Barrett, 1971; Meudell, 1972; Murray and Newman, 1973) employed the following basic scheme: (1) present a visual display containing both verbal information and spatial information (in the case of den Heyer and Barrett, letters placed in some of the boxes of a 4 x 6 matrix), (2) during a retention interval require the subject to engage in either a verbal activity or a visual activity (in the case of den Heyer and Barrett, an addition task or a visual discrimination task) and (3) test for retention of the information in the display (the identity of the letters and the location of the boxes in which they were placed). If there are separate memory systems, an interaction between type of information and type of distraction activity should result. The verbal distraction task should interfere more with the rehearsal and retention of the verbal information, and the visual distraction should interfere more with the rehearsal and retention of the nonverbal information.

Although there were minor variations in the three studies, the predicted interaction was found in each case. In a study involving an imaginal task or a linguistic task followed by visual or auditory interference, similar results obtained (Atwood, 1971). Finally, Ternes and Yuille (1972) found that a period of verbal interference (counting backwards by three's) following the presentation of words and pictures depressed recognition memory for words but not for pictures.

## Rationale and Outline of the Research

The purpose of the research reported herein was to produce evidence that would lend support to one or the other of the two rival hypotheses.

The basic scheme was to show subjects a series of words and pictures intermixed. During the presentation, either (1) subjects were simultaneously engaged in an auditory verbal task designed to "tie up" the verbal processing system, or (2) they viewed the words and pictures free of any distraction. If a test of retention were to show that the verbal interference resulted in a decrement in the learning of words while not affecting the learning of pictures, this could be interpreted as evidence of independent processing and support for the dual-system hypothesis. On the other hand, if the verbal interference were to result in similar effects on words and pictures, this could be interpreted as evidence that the two are processed in the same manner as suggested in single-system hypotheses. (See Figure 1.)

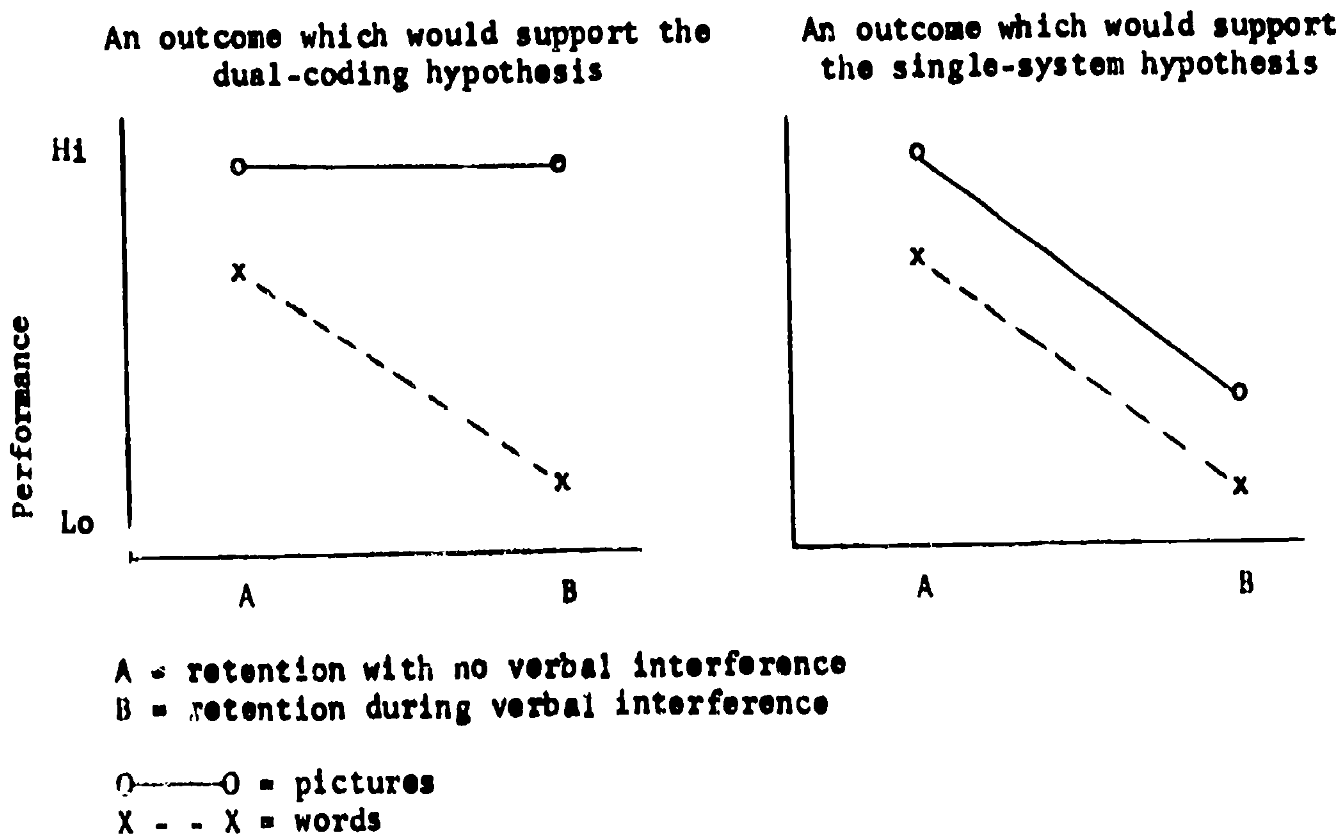


Figure 1: Outcomes which would support either the dual-coding hypothesis or the single-system hypothesis.

It will be noted that this scheme bears a resemblance to the research reviewed in the preceding section dealing with the effects of interference on the rehearsal and retention of verbal and nonverbal information. An important difference in the present research is that the interference was introduced during the learning phase rather than during the retention phase. This change is an improvement over past research since, as was noted earlier, rehearsal is much more important to the retention of verbal information than to the retention of pictorial information. While it has been demonstrated that verbal interference during rehearsal failed to hinder the retention of pictorial information (e.g., Ternes and Yuille, 1972), verbal interference during the learning phase might produce a deficit in performance.

The verbal interference used in the present research was the technique known as "shadowing." In this technique, subjects are directed to repeat aloud (shadow) spoken verbal material. Shadowing has been shown to interfere with the learning of simultaneously presented verbal information (e.g., Norman, 1969). In the present research, the materials to be learned were either pictures or nouns presented by projected slides at two second intervals. Learning was tested by recognition in the first three experiments and by free recall in the fourth experiment.

## EXPERIMENT 1

### Overview of Method

Experiment 1 was a recognition experiment. Each S was given two trials, each of which was itself divided into two parts. During one half of each trial, S was shadowing (listening to and repeating) a list of recorded words; during the other half of each trial S was not shadowing. The shadowing material used in one trial was composed of a list of high-imagery adjectives and in the other trial of a list of low-imagery adjectives. During each half of a trial, S was presented visually with 40 slides, half of which were words and half of which were pictures. At the conclusion of a trial, a recognition test was given. S was presented pairs of slides side-by-side on the screen. Each pair consisted of either words or pictures. There were 40 pairs, 20 pairs of pictures and 20 pairs of words. In each pair, one slide had appeared in the presentation series and one was a new slide (distractor item). S was asked to identify the slide he had previously seen by saying aloud "Left" or "Right." E recorded S's responses. S was given as much time as necessary, but in no case was more than a few seconds required.

### Subjects

Sixteen students from graduate level courses in the Indiana University School of Education volunteered to be subjects.

### Materials

Stimulus materials consisted of 35mm slides presented by a slide projector (or in the case of the test materials, two slide projectors) and of audiotape recordings to be used in those experimental conditions involving shadowing tasks.

Visually presented material consisted of word and picture slides selected randomly from pools. The pools of word slides included 60 concrete words and 60 abstract words taken from a published list (Paivio, Yuille, and Madigan, 1968). Words in the concrete word pool had values of $I > 6.50$ and $C \geq 6.90$; words in the abstract word pool had values of $I < 3.00$ and $C \leq 2.50$ (See Appendix A). The pools of picture slides included 60 pictures designated as low similarity pictures and 60 pictures designated as high similarity pictures. The low similarity pool was assembled as a result of E's sorting through several thousand slides on file in the Indiana University Audio-Visual Center. These were photographed for a variety of purposes (e.g., instruction, public relations, vacation) and by a variety of individuals. They included pictures of real world objects and people, drawings and paintings, abstract diagrams, and so forth, and they were in both color and black-and-white. E made a highly subjective effort to select slides thought to be interesting and/or memorable. The high similarity pool was assembled by delegating one graduate student in photography to "Go out in the world and take some pictures of things which attract you." These pictures, then, had the commonality of having been taken by one person with one purpose and one camera; they were of real world objects in one community at one time and all in color. Pictures were excluded from both low and high similarity pools if they included recognizable words (e.g., a readable street sign), if they subjectively seemed recognizable as a specific place in this community (e.g., local ice cream store window), if they subjectively appeared to be of the same labelable content as that denoted by words in the concrete word pool, or if they seemed subjectively similar to other pictures already in the pool (e.g., not more than one picture of an automobile was included).

The visual stimulus presentation consisted of two trials, each of two parts. Each part of each trial had 40 slides, 10 of which were concrete words and 10 of which were abstract words. Both parts of one trial utilized high similarity pictures, and both parts of the other trial utilized low similarity pictures. Given that these conditions were fulfilled, random selection from the pools was made for all slides.

After the two parts of a trial had been presented (one with and one without shadowing), a recognition test was given. This consisted of the simultaneous presentation of two slides, one of which was chosen from the preceding stimulus presentation and one of which was a distractor item never seen before. Given that they equally represented the two parts of the trial and proportionately represented the various slide types existent in the parts of the trial, the slides chosen from the previous presentation were randomly chosen. (For example, there were 10 abstract words in the first part of a trial and 10 abstract words in the second part of a trial. Hence, abstract stimulus words chosen for testing would include 5 chosen at random from the first 10 and 5 chosen at random from the second 10.) Distractor or new items used in the test were chosen at random from the general pools. Each pool had 60 items; the two trials used 40 items and the two tests used the remaining 20.

The slides were presented during the stimulus presentation by an automatic timer at 2 second intervals. Pairs of slides were presented during the test presentation by E at the rate of S response.

Auditory material for shadowing consisted of adjectives recorded at 1 second intervals by a male voice on two tapes. One tape consisted of high-imagery adjectives (I-value $\geq$ 4.25 and Thorndike-Lorge Frequency $\geq$ 100) and the other of low-imagery adjectives (I-value $\leq$ 3.00 and Thorndike-Lorge Frequency $\geq$ 50) taken from an unpublished list provided by Paivio. These lists appear in Appendix B.

## Procedure

Experiment 1 was conducted in conjunction with and used the same subjects as a pilot recall study not reported here. Ss underwent this pilot study first and were given instructions (which included shadowing practice) quite similar to those noted in the procedures section of Experiment 4. The following instructions, then, were those given at the completion of experiment 4.

Instructions

> Now we come to Part II of the experiment. Here you'll see slides of many different types of pictures and of words -- all mixed up. Once again some of the time while you are looking at slides, you will also be shadowing. As before, your job is to remember the slides you see, but this time, after two sizeable groups of slides, you will be shown pairs of slides. One of each pair will be a slide you've seen before and one a new slide. Your job is to pick out the old one. It is also very important that you shadow accurately.

Subsequent instructions depended on whether S was to shadow first or second.

For Ss who were to shadow first, the instructions continued as follows:

> Again you'll wear the earphones throughout the entire experiment although you'll only be hearing words and shadowing part of the time. When you put the earphones on and look at the screen, I will start tape recorder. After I have heard you shadow a few words, I'll start the slides. Ready?
>
> (After 2 words had been shadowed, E began the visual display. The tape was continued and S shadowed for 8 additional words after the visual display was concluded.)
>
> Now I will show you another group of slides. You will not be shadowing during this group. Just look at the screen and try to remember the slides you see.
>
> (E presented the visual display.)
>
> Now you will see pairs of slides. One will always be a slide you've seen before and one will always be a new slide. Your job is to tell me which slide you've seen before. Just say "Left" or "Right" for the old slide. If you don't know, make your best guess.

(E presented pairs of slides at S response rate and recorded S's responses on a mimeographed form.)

During this trial, S saw either all "high-similarity" or all "low-similarity" pictures. Next, the procedure was repeated, and S saw the type of picture not shown in the first trial. In order to control for any possible order effects of (1) the shadowing condition, (2) the high-low picture similarity condition, or (3) the high-low imagery value of the shadowing material condition, all these conditions were balanced and Ss randomly assigned to a given combination of conditions.

## Results

The results of primary interest are shown in Table 1. The shadowing activity had no effect upon the recognition of either words or pictures. The recognition accuracy for the two types of material is consistent with that found by other researchers, and the main effect for words versus pictures was significant. None of the other variables showed significant main effects nor were there any significant interactions. The raw data and the analysis of variance summary table appear in the Appendix C and Appendix D.

Table 1

Recognition Scores and Percentage Accuracy for Words and Pictures under Adjective Shadowing and No Shadowing Conditions

| | Words | Pictures |
|---|---|---|
| Shadowing Condition | 246 (77%) | 302 (94%) |
| No Shadowing Condition | 243 (76%) | 306 (95%) |

## Discussion

Two of the failures to produce differences are of interest. The first of these is the lack of a difference between the recognition of concrete words (78% accuracy) and abstract words (74% accuracy). An analysis of variance for only the words in the study resulted in a p value of about .25. This finding fails to support research by German (1961) and Atkinson and Juola (1973) who report better recognition for concrete words than for abstract words.

The second item of interest is that the high-similarity and low-similarity pictures were recognized with equal accuracy -- in fact with exactly equal accuracy, there being a total of 304 correct recognitions in 320 opportunities for both sets of pictures. This result was somewhat surprising to the authors since it had subjectively appeared to them that the low-similarity set was on the whole a more interesting group of pictures with less interstimulus similarity. Research by Standing (1973) shows that a set of pictures selected for its vividness was more recognizable than a set which was not. Other researchers have shown that recognition rates are depressed when there is considerable interstimulus similarity in the stimulus population (Goldstein and Chance, 1970). The present research indicates that these pictorial stimulus variables will have effect on recognition memory only when their differences are maximized.

The especially surprising (and especially disappointing) finding was that the shadowing activity had no effect on either word or picture recognition memory. This result was in contradiction of a short pilot study conducted by the authors and of all previous research with which the authors are familiar. The surprise, of course, is that the verbal shadowing task failed to inhibit learning of words. Apparently the rate of presentation of the shadowing material -- one word per second -- was slow enough to allow for processing of the visual material, even though Ss seemed to "have their mouth's full" and occasionally had difficulty shadowing accurately. In any event, the authors' next task was clear. In order to provide any test of the central hypothesis, it was necessary to find a shadowing task which would have some effect on recognition memory of visually presented material.

## EXPERIMENT 2

### Overview of Method

In Experiment 2, Ss underwent three trials, each of which involved equivalent sets of visually presented word and picture slides, but each of which differed significantly from the others in the nature of the simultaneous activity engaged in. These activities were (1) a word shadowing task, (2) a prose shadowing task, and (3) a classification task. After each trial, a recognition test involving sequential presentation of one old slide (from the stimulus presentation) and one new slide (a distractor item) was given. S was asked to say "First" or "Second" to indicate which slide he had seen before.

### Subjects

The 12 Ss, graduate students in instructional systems technology in the Education Department of Indiana University, volunteered to be subjects.

### Materials

Stimulus materials consisted of 35mm slides visually presented by a slide projector and of tape recordings auditorily presented by earphones.

Three equivalent sets--each of 32 pictures and 32 words--were randomly selected from two pools of slides. The picture pool included the 60 "high similarity" pictures and the 60 "low similarity" pictures of Experiment 1. In addition, 12 "high similarity" and 12 "low similarity" pictures were added for a total picture pool of 144. The high-low similarity sets had proved to be indistinguishable in the results of Experiment 1; hence they were combined and treated as equal members of one large set in Experiment 2, i.e., simply pictures. The word pool was composed of approximately half concrete and half abstract words. These included the 60 concrete and 60 abstract words of Experiment 1 plus an additional 11 concrete and 13 abstract words chosen in the same way as in the earlier experiment. Hence the total word pool contained 144 words. Each of the three equivalent sets of stimuli was composed of 32 randomly chosen pictures, 16 randomly chosen abstract words, and 16 randomly chosen concrete words.

Audiotape recordings by the same male voice used in Experiment 1 were made to deliver the auditory tasks. The word shadowing task consisted of a combination of the high and low imagery adjectives used in Experiment 1. The prose shadowing task consisted of a recording of an excerpt from the Constitution of the United States (Article III, Sections 1 and 2). The classification task consisted of a list of nouns recorded at two second intervals. Each noun was one readily classifiable as "animal," "plant," or "mineral." (See Appendix E.) For example, three of the words on the list are "goose," "daffodil," and "emerald." Upon hearing these words, S was to respond "animal," after the first word, "plant" (or "vegetable") after the second word, and "mineral" after the third word.

Procedure

Experiment 2 involved 12 Ss, each of whom received the following initial instructions:

> This is an AV experiment and it should take about 30 minutes. I will show you slides of words like this.....
>
> (E presented a sample "word" slide.)
>
> and slides of pictures like this...
>
> (E presented a sample "picture" slide.)
>
> After showing you a tray of slides -- some words and some pictures -- I will then show you pairs of slides, one after the other, and ask you to tell me which slide you've seen before. One of the pair will always be a slide you've seen before and one will always be a new slide. For example, which of these slides have you seen before--the first or the second? Wait until you've seen them both before you answer.
>
> (E presented two "picture" slides, the second of which was the same as that already presented to S.)
>
> Right. Altogether, I will show you three trays of slides. With each tray, I will ask you to do something else simultaneously while you are watching slides.

S was then given either the instructions for the classification task or the instructions for the first shadowing task (regardless of whether it was a word or a prose shadowing task). The instructions for the classification task were as follows:

> For this tray of slides I would like you to simultaneously play a sort of animal-plant-mineral game. On the earphones, you will hear the name of either an animal, a plant, or a mineral. Your task is to say immediately which it is aloud. For example, on the short practice list I will give you, the first word is

"shale," and you should immediately respond by saying "mineral." The second word is "pepper," and you should say "plant," and the third word is "buffalo," and you should say "animal." Please put on the earphones and try it. If you should miss one, that's okay. Just wait for the next word and continue.

The instructions for the first shadowing task were as following:

During this set of slides, I would like you to shadow the words you hear on the earphones. Repeat aloud the words you hear immediately.

(If prose was first, E demonstrated how to shadow.)

Now, you try it.

(If S had trouble, as was often the case when the prose shadowing task was first, the practice tape was backed up. Otherwise, practice continued to the end of the practice tape.)

Okay, it is important that you shadow accurately. I will not test you on these words you shadow. I will test you only on the slides. However, do your very best to shadow the words accurately. If you miss something, just "throw it away" and dive in again.

When S received his second shadowing task, the following instructions were given:

And the instructions for the second shadowing task were as follows:

For this tray, I would like you to again shadow the words you hear. Try this...

(S received a practice tape. E demonstrated the prose shadowing if it was second.)

Again, it is important that you do your very best to shadow accurately.

Each S received three trials. A trial consisted of the visual presentation of a 64 item set of word and picture slides accompanied by a tape recording involving one of three experimental conditions (word shadowing, prose shadowing, or classification task). There were six possible orders for the three experimental conditions and also for the three equivalent slide sets. Given that the requirement of two Ss per order was met, a given S was randomly assigned to one of the six experimental condition orders and one of the six slide set orders.

After looking at the slides and simultaneously performing the task indicated by the auditory material, S was given a recognition test. This test involved the sequential presentation of two slides, one of which he had not seen before (distractor). The position of these two (first or second) was randomly determined. S indicated the "old" item by saying "First" or "Second." E recorded the answers.

## Results and Discussion

The primary results are shown in Table 2. The main effect for words versus pictures was the only significant difference in the analysis of variance (see Appendix G). However, a post hoc t-test for the difference between the retention of words under the adjective shadowing and prose shadowing conditions proved to be significant at the .05 level. The recognition rate of 60% for words under the prose shadowing condition approaches the chance level of 50%. Also, it was very apparent during the administration that Ss were having the most difficulty in the prose condition, and several of them commented to this effect.

Table 2

Recognition Scores and Percentage Accuracy
for Words and Pictures under Three Shadowing Conditions

| | Words | Pictures |
|---|---|---|
| Adjective Condition | 135 (70%) | 178 (92%) |
| Prose Condition | 116 (60%) | 167 (87%) |
| Anim-Veg-Min Condition | 128 (67%) | 172 (90%) |

Parenthetically, a problem which arose during this study was the question of how to treat data obtained from Ss who did not shadow errorlessly. It could be argued that an S who made shadowing errors was not attending to th, shadowing task, but was devoting his sole attention at that moment to the visual material. Subjectively, this did not appear to be the case during the administration. Ss who had the most shadowing difficulty did appear to be trying and were usually the Ss who did poorest on the recognition test. In fact it could be argued that shadowing errors are preferred, since as Norman (1969) notes, errorless performance may mean that the S has spare capacity to process the non-attended message.

# EXPERIMENT 3

Although this experiment can be thought of as a replication of Experiment 1, Experiment 3 differed from the first experiment in the following important ways:

1. Ss shadowed prose material rather than the adjectives used in Experiment 1. This change was introduced because of the results of Experiment 2 showing prose to be more effective in depressing word recognition than the adjective shadowing task.

2. In Experiment 3, Ss were given more extensive training and practice in shadowing prior to the experimental administration.

3. In the test phase, Ss were given four simultaneously presented alternatives to choose from rather than two alternatives as in Experiment 1. This change would result in chance scores of 25% rather than 50%, and offer the possibility of obtaining a wider spread in performance scores. Kintsch (1968) showed that increasing the number of alternatives in a multiple-choice recognition test decreased performance scores.

4. In the test phase, the type style of the words was different from the type style of the words in the presentation. The presentation words were a print style produced by a mechanical lettering device. The test words were an italic style produced by a typewriter. This change was introduced to make recognition of the words depend upon verbal memory, not upon physical features of the verbal stimuli. An experiment had been conducted earlier by the authors in which recognition of same-style words was compared with the recognition of different-style words. While the results were in the predicted direction (same-style performance being superior to different-style performance), the difference failed to reach significance. Other researchers, however, have obtained significant results. For example, Kirsner (1973) used a continuous recognition memory test in which each word was presented twice, either in the same print or in different print on the two occasions. Results showed that recognition performance was facilitated in the same-print condition. Similarly, Kellicutt, Parks, Kroll, and Salzberg (1973) found that the recognition of letters was more rapid and accurate when test and presentation letters were physically identical rather than the same in name only.

5. In Experiment 3, confidence ratings were also obtained. After each response in the test phase, S indicated the degree of confidence he had in the accuracy of his response by stating that he was "Very sure," "Moderately sure," "Unsure," or that his response was "Just a guess."

## Overview of Method

Each of 16 Ss had two trials. In each trial, S saw a presentation of 60 slides, 30 of which were pictures and 30 of which were words. The two trials differed in that one involved no shadowing or auditory task while the other trial required S to shadow prose material heard through earphones at the same time he was presented with slides to be remembered for later recognition. Half of the Ss did the shadowing trial first; half did the nonshadowing trial first.

The words used in both the presentation phases and the test phases were half abstract and half concrete. The type style of the presentation words was print style while the type style of the test words was italic style.

Immediately after each of the two presentations, S was given a recognition test on 20 items randomly selected from the prior presentation items. (The selection was random given that the balance of picture, abstract word, and concrete word was the same as that in the presentation.) Each of the 20 test items involved 4 simultaneously presented slides---all pictures or all words---positioned in what might be described as a 2 x 2 matrix. One of the four slides was always an old item, i.e., an item previously seen during the presentation phase. Three of the slides were always new or distractor items. Old or "correct" items were randomly located among the 4 possible positions. S was asked to indicate the old item by saying "Top left," "Top right," "Bottom left," "Bottom right." These responses were recorded by the experimenter on a mimeographed form. Also recorded by the experimenter were S confidence ratings on each item.

## Subjects

The 16 Ss were Indiana University students enrolled in graduate level courses in the School of Education. All volunterred to be Ss. Half were female and half male.

## Materials

The words and pictures used as presentation and test material came from the same pools as used in Experiment 2, with the previously noted exception of the test words. The auditory shadowing material was the audiotape of a section of the U.S. Constitution used in Experiment 2. Additional readings from the Constitution were recorded by the same voice for use in the initial, extended practice phase.

Procedure

S was first shown samples of the presentation and test material, and instructed in how to report his responses. He was then told now to report confidence ratings as follows:

> After telling me which slide you think you saw before, I would like you to tell me how certain you are that you made the correct choice. Tell me by selecting one response from the card on the table beside you. (The card listed the following responses: (1) "very sure," (2) "moderately sure," (3) "unsure," (4) "just a guess.") If you are very sure that you were able to pick out the slide you saw before, say "Very sure," and so forth. If you really just can't tell which of the four slides it was, make a guess anyway and tell me "Just a guess."

Ss were then instructed in the shadowing technique, after which they were given two practice periods. The first period consisted of a one minute section from the Constitution. The second practice period consisted of a 45 second section. During this period a set of stimulus slides similar to those which would be used in the experiment were shown along with the shadowing material. Ss consequently knew exactly what to expect during the experiment. Following the practice, Ss were instructed,

> (For Ss who shadowed first.)
> Now we will do it for real. Repeat the words as accurately as you can and watch the slides carefully. Watch the screen and begin repeating as soon as you hear the words begin.

About two seconds after S began to shadow, the visual stimuli began to appear at two second intervals. After the last slide, the shadowing material continued for about eight seconds. Prior to the testing, there was a pause of about 20 seconds while E readied the apparatus for displaying the test slides. Following the test for Trial 1, S was administered Trial 2, either not shadowing or shadowing, whichever condition he did not have in the first trial.

Results

In Experiment 3, the main effects for shadowing condition and for pictures versus words were both significant at the .01 level (see Appendix I). More importantly, the interaction was also significant at the .01 level. The shadowing condition depressed word performance but had negligible effect upon pictorial recognition memory. (See Table 3.)

Table 3

Recognition Scores and Percentage Accuracy
for Words and Pictures
under Prose Shadowing and No Shadowing Conditions

| | Words | Pictures |
|---|---|---|
| Shadowing Condition | 70 (44%) | 149 (93%) |
| No Shadowing Condition | 110 (69%) | 154 (96%) |

The same significant differences that were produced for the recognition data were found for the confidence ratings. Confidence ratings were higher for pictures than for words, higher for the no shadowing condition than for the shadowing condition, and the interaction was significant. The shadowing task resulted in a greater drop in confidence for the words than for the pictures. The confidence rating of "Very sure" was assigned a score of 3, "Moderately sure" a score of 2, "Unsure" a score of 1, and "Just a guess" a score of 0, so that in Table 4, the average rating for words in the no shadowing condition was "Moderately sure" while the average rating for pictures under the same condition was midway between "Moderately sure" and "Very sure." The shadowing task resulted in a drop of 0.3 points for pictures and 0.7 points for words. While the reader is cautioned that this rating scale should not be considered to be a strict interval scale, the results could nevertheless be interpreted as indicating that the verbal interference produced a greater drop in confidence to retain and recognize verbal material than pictorial material.

Table 4

Average Confidence Ratings
for Words and Pictures
under Prose Shadowing and No Shadowing Conditions

| | Words | Pictures |
|---|---|---|
| Shadowing Condition | 1.3 | 2.2 |
| No Shadowing Condition | 2.0 | 2.5 |

Discussion

The interaction between the shadowing conditions and the stimulus types was earlier identified as the effect which would tend to support the dual-encoding hypothesis. This interaction was obtained; verbal interference (shadowing) produced a large decrement in word recognition while having essentially no effect upon picture recognition.

It is interesting to compare the percentage accuracies in this experiment with those in Experiment 1. Remember that in Experiment 3 not only was the shadowing task more difficult, but the test was also more difficult, involving a choice from among four alternatives rather than from two alternatives. Nevertheless, pictorial recognition accuracy remained at a constant level. Word recognition accuracy suffered only slightly in the no shadowing condition (69% with four alternatives and 76% with two alternatives in Experiment 1).

While the authors were conducting the present set of studies, a similar experiment was reported in the literature. Rollins and Thibadeau (1973) compared recognition of items in shadowing and no shadowing conditions. They presented a prose passage via earphones to one ear for the shadowing task. Ss were to learn either (1) words presented auditorially via earphones to the second ear, (2) words presented visually, (3) pictures of common objects, or (4) pictures of fictitious animal-like characters which were designed to be hard to attach verbal labels to. Shadowing produced a significant decrement in the recognition of the first three types of items, but not for the fictitious characters. The authors state that "...attending to an auditory message interferes with the processing and storage of any information whether visually or auditorily presented when that information can be verbally labeled." (p. 166)

The two conditions from the Rollins and Thibadeau study which most nearly match the present study are those involving visually presented words and pictures of common objects. The comparison of greatest interst here is that involving pictures. Rollins and Thibadeau obtained a rate of 94% in the no shadowing condition and 78% in the shadowing condition. Numerous researchers have found that pictures presented sequentially at two second intervals with no or negligable intervening "blank" time consistently result in recognition rates of around 95%. This rate is comparable to the rate found in Experiment 3 with or without shadowing, which has been interpreted herein to suggest that picture memory is not affected by verbal shadowing tasks. This rate is also comparable to that obtained by Rollins and Thibadeau in their no shadowing condition (94%). However, Rollins and Thibadeau used a one second presentation period, which in other studies (Potter and Levy, 1969) resulted in performance rates of about 80%. The explanation may lie in the fact that while Rollins and Thibadeau used a one second presentation, this period was followed by a 1.6 second blank period during which time rehearsal could occur. Since other researchers have indicated that picture memory does not benefit from rehearsal, it might be assumed that the rehearsal advantage occurring here, if indeed it is occurring, must be in a verbal form. That is to say, in the Rollins and Thibadeau study, under the picture-no shadowing condition, Ss used the blank period to recode the picture material into a verbal form which they then rehearsed. This same explanation could also account for the reduced performance when pictures are accompanied by shadowing, since under these circumstances verbal rehearsal is greatly reduced by the shadowing task.

If the preceding explanation is viable, a modification of the conclusion offered by Rollins and Thibadeau would be that attending to an auditory message interferes with the processing and storage of visually presented information _if_ that information is verbally labeled.

# EXPERIMENT 4

Would the results obtained in Experiment 3 be produced if the measure of retention were recall rather than recognition? Frost (1972) showed that pictures are encoded differently depending upon task expectation. Tversky (1973) found that both words and pictures are encoded differently depending upon the expected use of the information. Performance was better when Ss were tested in the way they were anticipating (either recognition or recall) than when they were tested in the unanticipated mode, suggesting the use of different encoding strategies during the learning phase. Hence an experiment was conducted to see if shadowing would have effects upon recall performance (and the strategies involved) that were similar to the effects upon recognition.

## Overview of Method

Each S was given four trials. Each trial consisted of the presentation of 12 slides. In two trials the material-to-be learned was concrete nouns and in two trials the material-to-be learned was line drawings. During one of the word trials and one of the picture trials, S shadowed a section of the U.S. Constitution. After each trial, S wrote down all of the items he could remember.

## Subjects

The 16 Ss were graduate students in Indiana University School of Education. All volunteered to be Ss.

## Materials

Stimulus materials consisted of 35mm slides presented by a slide projector and an interval timer at a 2 second presentation rate and portions of the tape recordings used in Experiment 3.

Using as a general source a commercially prepared set of elementary level flashcards of concrete objects, a pool of 48 simple concepts was developed (see Appendix L). A slide was prepared showing each concept as a word and another slide was prepared showing the concept as a simple line drawing. For each S a different random order of these 48 concepts was devised. That is to say, whether a concept was presented as a word or as a picture, and the order in which each concept was presented, was determined randomly for each S. The order in which each S received each treatment (whether word or picture, shadowing or not shadowing) was also randomly determined.

## Procedure

Ss received the following instructions:

> We are studying how people remember visual displays under various conditions. In this experiment I will be showing you slides like this.
>
> (E presented sample word and picture slides.)
>
> Some of the time you will be looking at pictures and some of the time you will be looking at words. Also, some of the time while you are looking at slides you will also be shadowing, that is, listening to and repeating words, like this.
>
> (E gave a short demonstration and then had S put on earphones and try a short section.)
>
> As you have probably guessed, these are some sections of the U.S. Constitution. Do not worry about remembering what you hear. I will not in any way test you about what you hear and repeat, but it is important that you do your best to shadow accurately. This is not a particularly easy thing to do at first, so I'd like to give you a little practice. Here is an about one minute section. Face the screen, and do your best to shadow accurately.

Following this practice session, Ss were shown how to provide recall responses on a provided form, and were instructed to wait until E instructed them to begin before writing down the items they could recall. They were then given a practice trial with four slides, two words and two pictures. After this practice trial, Ss were instructed:

> Right. If it's a picture, give the single word that labels the picture. If it's a word, just give the word, but remember to wait until I say "begin." Altogether you will see four different groups of slides. There will be 12 slides in each group. Here is the form for the first group. This group will be all (words, pictures), and you (will, will not) be shadowing. ON SHADOWING TRIALS THE INSTRUCTIONS CONTINUED: Now look at the screen and when you hear the words on the earphones, begin shadowing and continue shadowing until the words end. Then when I say "begin" write down as many slides as you can, and do your best to shadow accurately. ON TRIALS WHEN S WAS NOT TO SHADOW: Now look at the screen. Then afterwards when I say "Begin" write down as many slides as you can.

During the shadowing trials the shadowing material began about two seconds prior to the presentation of the first stimulus and continued on for about eight seconds after the last slide, after which Ss were immediately instructed to begin writing. In the non-shadowing trials, Ss were instructed to begin writing after an eight second delay following the last slide. Ss were given as long as they wished to recall, but in no case did an S take more than three minutes. Typically Ss took about one and a half minutes to respond. E removed the response form used after each trial and gave S a new form.

## Results and Discussion

In Experiment 4, the main effect for shadowing was significant ($p < .01$) as was the main effect for words versus pictures ( $p < .05$). The interaction, however, failed to achieve significance (see Appendix N). Table 5 shows the average number of concepts recalled out of a possible 12 presented in each of the four conditions. Shadowing reduced recall of words by 56% and recall of pictures by 36%.

Table 5

Average Number of Words and Pictures Recalled under Prose Shadowing and No Shadowing Conditions

| | Words | Pictures |
|---|---|---|
| Shadowing Condition | 3.2 | 4.9 |
| No Shadowing Condition | 7.2 | 7.6 |

The failure to produce a significant interaction between stimulus type and shadowing condition is not consistent with the results reported by Hall and Swane (1973) and by Hall, Swane and Jenkins (1973). In the former study, color patches or color names were presented to Ss shadowing words presented at the rate of two words per second. A test for recall in serial position showed better performance for color patches than for color names. Although the design of the experiment did not allow for the determination of a stimulus type by shadowing condition interaction, a group of control Ss did equally well with patches as with names. In the Hall, Swane and Jenkins (1973) study, similar results were obtained for "physical inputs" consisting of geometric figures varying in form, number of figures and color versus the "semantic input" of the name of the figures (e.g., three black circles).

Why was the interaction produced in Experiment 3 not found in Experiment 4? It has been noted (Tversky, 1973) that recognition tests may eliminate the retrieval stage of memory necessary in recall tests. In pictorial recognition, it is a logical possibility that no verbal transactions need be involved. The results of Experiment 3 are compatible with this point of view. In pictorial recall, however, a verbal response is necessary; hence, some kind of verbal transaction must be involved. Information processing strategies for pictorial recall might consist of storing some sort of untranslated iconic representation in memory, and, when recall is demanded, searching this storage, retrieving from it, and only then translating the iconic storage into verbal form. However, such a description is not consistent with the results of Experiment 4; verbal interference was present during presentation, not during recall, and given the processing strategies outlined above, should not then depress performance on pictures. But, what if the nature of the experimental task (i.e., Ss' awareness that recall, not recognition, was the performance task required) led Ss to translate the pictorial stimuli into words during the presentation stage? This explanation would account for the depressed performance on pictures presented under the shadowing condition and for the absence of a significant interaction in Experiment 4.

# SUMMARY AND CONCLUSIONS

## Summary

The purpose of this research was to provide evidence to support either the dual-encoding hypothesis or single-system hypotheses of human memory.

In single-system hypotheses the same mechanisms are used to account for the processing of both verbal and pictorial stimuli. Such explanations include the verbal-loop hypothesis (Glanzer and Clark, 1964), the frequency theory account of picture-word differences in discrimination learning (Levin, Ghatala, and Wilder, 1974), and Anderson and Bower's (1973) single conceptual system in which knowledge from both pictures and words is represented in the form of abstract propositions. The dual-coding hypothesis (Paivio, 1971) proposes two separate memory systems, one for verbal symbolic processes and another for nonverbal imagery. While the two systems are thought to be richly interconnected, it is supposed that they also may function independently.

Experiments were conducted to test the independence of memory for words and pictures. The basic paradigm was to compare the retention of visually presented words and pictures under two conditions. In the first condition, Ss were shown the visual material while they were simultaneously engaged in an auditory verbal task designed to "tie up" the verbal processing system. In the second condition, Ss viewed the words and pictures free of any distraction. If, under the "verbal interference" condition, performance were decreased for words but not for pictures, this could be interpreted as an indication that verbal and pictorial stimuli may be processed by separate memory systems as proposed in the dual-coding hypothesis. If, on the other hand, the "verbal interference" were to result in similar decrements in picture performance and word performance, this could be interpreted as lending support to single-system hypotheses of human memory.

Word and picture retention was assessed by recognition and by recall in separate experiments. The first three experiments dealt with recognition. Experiment 3 embodies the resolution of certain methodological problems existent in Experiments 1 and 2; hence only Experiment 3 is reviewed below.

In Experiment 3, each of the 16 Ss was given two trials. Each trial consisted of a mixture of 30 words (concrete and abstract nouns on 35mm slides) and 30 pictures (vacation slides, instructional illustrations, etc.) presented at two second intervals. During one of the trials Ss also shadowed (repeated aloud) a prose passage presented via earphones. Immediately after each of the two presentations, Ss were given a recognition test on 10 words and 10 pictures from the prior presentation. Each "old" item was accompanied by three "new" or distractor items. The type-style of the words shown during the learning phase was different from the type-style of the words used in the recognition test. This was done so that word recognition would be dependent upon verbal memory and not upon physical features of the verbal stimuli.

The main effects for words versus pictures and for shadowing conditions as well as the interaction were all significant ($p < .01$). As shown in Figure 2, the shadowing activity depressed word performance but had negligible effect upon pictorial recognition memory.

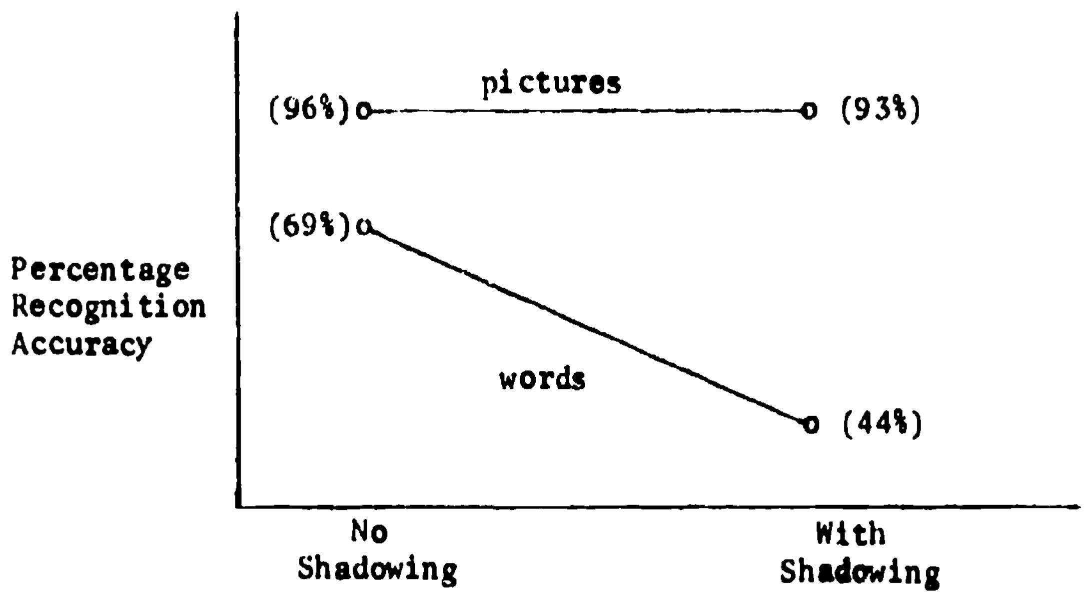


Figure 2: Percentage recognition accuracy for words and pictures under no shadowing and shadowing conditions.

This evidence corrobrates earlier research showing that verbal activity such as counting backwards by three's during a retention period produced more interference with retention of verbal material than of nonverbal material. However, since it has also been shown that the retention of pictorial information is much less dependent upon rehearsal than the retention of verbal information, the present design which introduced the verbal interference during the learning phase rather than during the retention and rehearsal phase is thought to be an improvement over previous research of this kind.

Experiment 4 was conducted to see if the shadowing activity would produce similar effects upon free recall. Each of the 16 Ss were given four trials. Each trial consisted of 12 slides presented at two second intervals. Two trials showed concrete nouns and two showed simple line drawings. (The 48 concepts used were prepared in both word and picture form.) During one of the word trials and one of the picture trials Ss shadowed prose material of the type used in Experiment 3. After each trial Ss wrote down as many of the stimuli as they could recall.

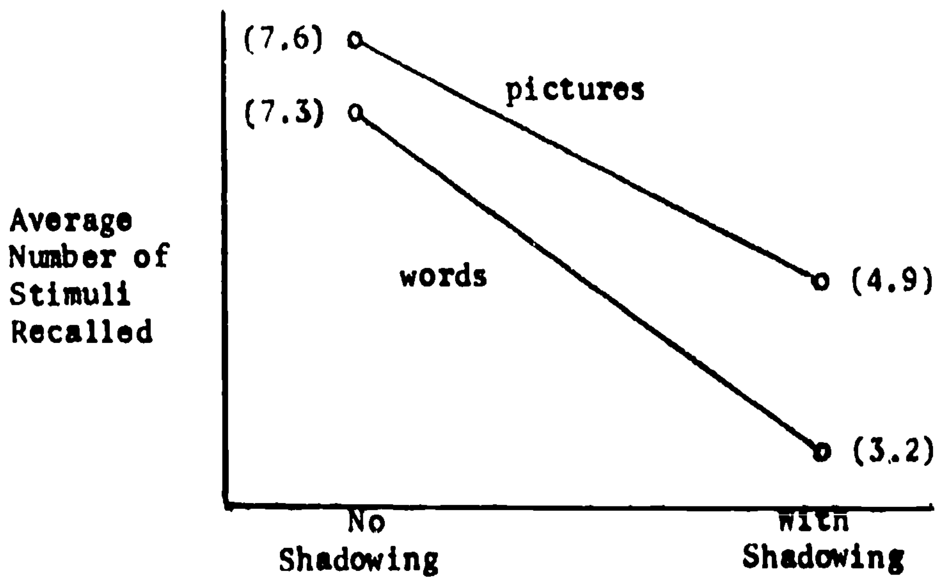


Figure 3: Average recall for words and pictures under no shadowing and shadowing conditions

The results showed a main effect for words versus pictures ($p < .05$) and for shadowing conditions ($p < .01$). The interaction between stimulus type and shadowing condition was not significant. As shown in Figure 3, the shadowing activity disrupted recall of both picture and word stimuli. The authors speculate that the failure to obtain an interaction similar to that found with the recognition data was due to the likelihood that Ss attempted to translate the easily labelable pictures into words during the presentation stage and that this process was disrupted by the shadowing task.

Conclusions

Is there a separate visual iconic memory system? Yes. The results of Experiment 3 provide strong evidence that verbal and pictorial information may be processed independently in parallel recognition memory systems. The finding that the verbal shadowing task produced a large decrement in word recognition while resulting in essentially no decrement in pictorial recognition memory is very striking.

The results of Experiment 4 serve to emphasize that the independence of the verbal and nonverbal systems may be preserved only when no verbal transactions are necessary. Even though material to be learned is presented in pictorial form, it cannot be guaranteed that the information will be processed primarily or even partially by the visual iconic component of memory. Under some circumstances, Ss may "instruct themselves" to reply primarily upon verbal translations of pictorial information in memory tasks.

While there is always danger in extrapolating results from laboratory experiments to prescriptions for instructional practice, some implications may be offered with an unusually high degree of confidence in this case. The experimental conditions in which meaningful pictures and words were presented in conjunction with non-redundent meaningful prose is analogous to many types of audiovisual presentations used in education. Producers and users of audiovisual materials such as sound motion pictures may be advised that, under circumstances when the receiver (student) is attending to verbal information in the sound track, (1) considerable loss of information from non-redundant visually presented verbal material may be expected, (2) considerable retention of pictorial information may be expected if retention is measured by recognition, and (3) it is probable that considerable loss of pictorial information will occur if retention is tested by verbal report.

REFERENCES

Anderson, J. R., & Bower, G. J. Human associative memory. Washington, D. C.: V. H. Winston & Sons, 1973.

Atkinson, R. C., & Juola, J. F. Factors influencing speed and accuracy of word recognition. In S. Kornblum (Ed.), Attention and Performance IV. New York: Academic Press, 1973, pp. 583-612.

Atwood, G. An experimental study of visual imagination and memory. Cognitive Psychology, 1971, 2, 290-299.

Bahrick, H. P., & Bahrick, P. Independence of verbal and visual codes of the same stimuli. Journal of Experimental Psychology, 1971, 91, 344-346.

Bahrick, H. P., & Boucher, B. Retention of visual and verbal codes of the same stimuli. Journal of Experimental Psychology, 1968, 78, 417-442.

Benjafield, J., & Dean, B. Similarities between memory for visually perceived relations and comparative sentences. Psychonomic Science, 1971, 24, 255-256.

Bower, G. J. Mental imagery and associative learning. In L. Gregg (Ed.), Cognition in learning and memory. New York: Wiley, 1972.

Cermak, G. W. Short-term recognition memory for complex free-form figures. Psychonomic Science, 1971, 25, 209-211.

Clark, H. H., & Chase, W. G. On the process of comparing sentences against pictures. Cognitive Psychology, 1972, 3, 472-517.

Cohen, G. How are pictures registered in memory? Quarterly Journal of Experimental Psychology, 1973, 25, 557-564.

Del Castillo, D. M., & Gumenik, W. E. Sequential memory for familiar and unfamiliar forms. Journal of Experimental Psychology, 1972, 95, 90-96.

den Heyer, K., & Barrett, B. Selective loss of visual and verbal information in STM by means of visual and verbal interpolated tasks. Psychonomic Science, 1971, 25, 100-102.

Frost, N. Encoding and retrieval in visual memory tasks. Journal of Experimental Psychology, 1972, 95, 317-326.

Galin, D., & Ornstein, R. Lateral specialization of cognitive mode: An EEG study. Psychophysiology, 1972, 9, 412-418.

Geffen, G., Bradshaw, J. L., & Wallace, G. Interhemispheric effects on reaction time to verbal and nonverbal stimuli. Journal of Experimental Psychology, 1971, 87, 415-422.

Ghatala, E. S., Levin, J. R., & Wilder, L. Apparent frequency of words and pictures as a function of pronunciation and imagery. Journal of Verbal Learning and Verbal Behavior, 1973, 12, 85-90.

Glanzer, J., & Clark, W. H. Accuracy of perceptual recall: An analysis of organization. Journal of Verbal Learning and Verbal Behavior, 1963, 1, 289-299. (a)

Glanzer, M., & Clark, W. H. The verbal loop hypothesis: Binary numbers. Journal of Verbal Learning and Verbal Behavior, 1963, 2, 301-309. (b)

Glanzer, M., & Clark, W. H. The verbal-loop hypothesis: Conventional figures. American Journal of Psychology, 1964, 77, 621-626.

Goldstein, A. G., & Chance, J. E. Visual recognition memory for complex configurations. Perception and Psychophysics, 1970, 9, 237-241.

Gorman, A. M. Recognition memory for nouns as a function of abstractness and frequency. Journal of Experimental Psychology, 1961, 61, 23-29.

Hall, R., & Swane, D. Memory in a bisensory selective attention task. Quarterly Journal of Experimental Psychology, 1973, 25, 309-315.

Hall, R., Swane, D., & Jenkins, R. A. Memory for physical and semantic features of visual material in a shadowing task. Journal of Experimental Psychology, 1973, 100, 426-428.

Hintzman, D. L., & Rogers, M. K. Spacing effects in picture memory. Memory & Cognition, 1973, 1, 430-434.

Jenkins, J. R. Effects of incidental cues and encoding strategies on paired-associate learning. Journal of Educational Psychology, 1968, 59, 410-413.

Kaplan, S., Kaplan, R., & Sampson, J. R. Encoding and arousal factors in free recall of verbal and visual material. Psychonomic Science, 1968, 12, 73-74.

Kellicutt, M. H., Parks, T. E., Kroll, N. E. A., & Salzberg, P. M. Visual memory as indicated by latency of recognition for normal and reversed letters. Journal of Experimental Psychology, 1973, 97, 387-390.

Kintsch, W. An experimental analysis of single stimulus tests and multiple-choice tests of recognition memory. Journal of Experimental Psychology, 1968, 76, 1-6.

Kirsner, K. An analysis of the visual component in recognition memory for verbal stimuli. Memory & Cognition, 1973, 1, 449-453.

Lantz, D., & Stefflre, V. Lanugage and cognition revisited. Journal of Abnormal and Social Psychology, 1964, 69, 472-481.

Levin, J. R., Ghatala, E. S., & Wilder, L. Picture-word differences in discrimination learning: I. Apparent frequency manipulations. Journal of Experimental Psychology, 1974, 102, 691-695.

Meudell, P. R. Short-term visual memory: Comparative effects of two types of distraction on the recall of visually presented verbal and nonverbal material. Journal of Experimental Psychology, 1972, 94, 244-247.

Milner, B. Memory and the medial temporal regions of the brain. In K. H. Pribram and D. E. Broadbent (Eds.), Biology of memory. New York: Academic Press, 1970.

Murray, D. J., & Newman, F. M. Visual and verbal coding in short-term memory. Journal of Experimental Psychology, 1973, 100, 58-62.

Nelson, D. L., & Brooks, D. H. Functional independence of pictures and their verbal memory codes. Journal of Experimental Psychology, 1973, 98, 44-48.

Norman, D. A. Memory while shadowing. Quarterly Journal of Psychology, 1969, 21, 85-93.

Paivio, A. Imagery and verbal processes. New York: Holt, Rinehart and Winston, 1971.

Paivio, A., & Csapo, K. Concrete-image and verbal memory codes. Journal of Experimental Psychology, 1969, 80, 279-285.

Paivio, A., & Csapo, K. Short-term sequential memory for pictures and words. Psychonomic Science, 1971, 24, 50-51.

Paivio, A., Rogers, T. B., & Smythe, P. C. Why are pictures easier to recall than words? Psychonomic Science, 1968, 11, 137-138.

Paivio, A., & Yarmey, A. D. Pictures versus words as stimuli and responses in paired-associate learning. Psychonomic Science, 1966, 5, 235-236.

Paivio, A., Yuille, J. C., & Madigan, S. Concreteness, imagery, and meaningfulness values for 925 nouns. Journal of Experimental Psychology Monograph Supplement, 1968, 76, (1, Pt. 2).

Potter, M. C., & Levy, E. I. Recognition memory for a rapid sequence of pictures. Journal of Experimental Psychology, 1969, 81, 10-15.

Rollins, H. A., & Thibadeau, R. The effects of auditory shadowing on recognition of information received visually. Memory & Cognition, 1973, 1, 164-168.

Sampson, J. R. Free recall of verbal and non-verbal stimuli. Quarterly Journal of Experimental Psychology, 1970, 22, 215-221.

Seamon, J. G., & Gazzaniga, M. S. Coding strategies and cerebral laterality effects. Cognitive Psychology, 1973, 5, 249-256.

Shaffer, W. O., & Shiffrin, R. M. Rehearsal and storage of visual information. Journal of Experimental Psychology, 1972, 92, 292-296.

Shepard, R. N. Recognition memory for words, sentences, and pictures. Journal of Verbal Learning and Verbal Behavior, 1967, 6, 156-163.

Smith, E. E., & Larson, D. E. The verbal loop hypothesis and the effects of similarity on recognition and communication in adults and children. Journal of Verbal Learning and Verbal Behavior, 1970, 9, 237-242.

Snodgrass, J. G., Volvovitz, R., & Walfish, E. R. Recognition memory for words, pictures, and words + pictures. Psychonomic Science, 1972, 27, 345-347.

Snodgrass, J. G., Wasser, B., Finkelstein, M., & Goldberg, L. B. On the fate of visual and verbal memory codes for pictures and words: Evidence for a dual coding mechanism in recognition memory. Journal of Verbal Learning and Verbal Behavior, 1974, 13, 27-37.

Sperry, R. W. Cerebral organization and behavior. Science, 1961, 133, 1749-1756.

Standing, L. Learning 10,000 pictures. Quarterly Journal of Experimental Psychology, 1973, 25, 207-222.

Ternes, W., & Yuille, J. C. Words and pictures in an STM task. Journal of Experimental Psychology, 1972, 96, 78-86.

Travers, R. M. W. Research and theory related to audiovisual information transmission. (Rev. ed.) Kalamazoo, Michigan: Western's Campus Bookstore, 1967.

Tversky, B. Encoding processes in recognition and recall. Cognitive Psychology, 1973, 5, 275-287.

Wicker, F. W. On the locus of picture-word differences in paired-associate learning. Journal of Verbal Learning and Verbal Behavior, 1970, 9, 52-57.

# APPENDIX A

## Word Pools for Experiments 1, 2, and 3

Concrete words

| | | | |
|---|---|---|---|
| accordian | clock | harp | revolver |
| alligator | coin | horse | snake |
| ambulance | cottage | lake | streamer |
| ankle | diamond | lawn | strawberry |
| arm | door | lemon | sugar |
| automobile | dress | leopard | table |
| baby | dove | lip | toast |
| barrel | fireplace | lobster | tower |
| beaver | flask | meat | truck |
| bird | flower | microscope | trumpet |
| bottle | fork | mosquito | umbrella |
| boy | fox | mountain | water |
| butter | frog | nail | whale |
| caterpillar | grass | potato | wine |
| cigar | hammer | refrigerator | yacht |

Abstract words

| | | | |
|---|---|---|---|
| ability | deceit | idea | perception |
| advice | democracy | intellect | perjury |
| agreement | disparity | interest | quality |
| attitude | distraction | irony | satire |
| attribute | duty | jeopardy | soul |
| belief | economy | knowledge | spirit |
| blandness | effort | malice | suppression |
| blasphemy | ego | mastery | tendency |
| capacity | essence | memory | theory |
| chance | exclusion | method | thought |
| clemency | famility | mind | truth |
| concept | fallacy | moral | unreality |
| crisis | fate | necessity | upkeep |
| criterion | hindrance | opinion | virtue |
| custom | hypothesis | opportunity | welfare |

# APPENDIX B

## Adjectives Used as Shadowing Material in Experiment 1

High-imagery list

| | | |
|---|---|---|
| afraid | full | rich |
| big | golden | round |
| black | green | soft |
| blue | happy | straight |
| bright | hard | strong |
| broken | heavy | sweet |
| clean | hot | tall |
| clear | large | thin |
| cold | little | warm |
| cool | narrow | white |
| dark | old | wild |
| dead | poor | yellow |
| deep | pretty | young |
| fresh | red | |

Low-imagery list

| | | |
|---|---|---|
| able | fixed | really |
| actual | former | recent |
| both | here | simple |
| chance | his | slight |
| civil | last | special |
| common | main | their |
| easy | more | that |
| entire | much | this |
| every | my | true |
| equal | nice | useful |
| false | only | vain |
| farther | perhaps | wrong |
| few | proper | |
| first | real | |

## APPENDIX C

Recognition Scores for Subjects in Experiment 1.

| Ss | Shadowing | | | | Non-Shadowing | | | |
|---|---|---|---|---|---|---|---|---|
| | Pictures | | Words | | Pictures | | Words | |
| | HiS | LoS | C | A | HiS | LoS | C | A |
| S1 | 10 | 10 | 9 | 10 | 10 | 10 | 9 | 7 |
| S2 | 10 | 10 | 8 | 8 | 10 | 10 | 9 | 9 |
| S3 | 10 | 10 | 9 | 9 | 10 | 10 | 9 | 8 |
| S4 | 8 | 10 | 7 | 6 | 10 | 9 | 7 | 8 |
| S5 | 8 | 10 | 9 | 8 | 10 | 10 | 10 | 9 |
| S6 | 8 | 10 | 7 | 7 | 10 | 10 | 9 | 8 |
| S7 | 10 | 8 | 9 | 5 | 8 | 10 | 8 | 5 |
| S8 | 10 | 9 | 7 | 8 | 10 | 8 | 5 | 9 |
| S9 | 10 | 10 | 9 | 9 | 8 | 5 | 5 | 6 |
| S10 | 7 | 10 | 7 | 7 | 10 | 10 | 6 | 8 |
| S11 | 10 | 10 | 10 | 7 | 10 | 10 | 9 | 8 |
| S12 | 8 | 9 | 9 | 5 | 10 | 9 | 7 | 6 |
| S13 | 10 | 10 | 8 | 8 | 10 | 10 | 4 | 8 |
| S14 | 10 | 9 | 8 | 8 | 10 | 10 | 10 | 8 |
| S15 | 10 | 9 | 7 | 4 | 10 | 10 | 6 | 8 |
| S16 | 9 | 10 | 8 | 6 | 10 | 9 | 8 | 7 |
| T | 148 | 154 | 131 | 115 | 156 | 150 | 121 | 122 |

NOTE: HiS pictures are the group designated as high in similarity and LoS pictures are those designated as low in similarity. "C" words are from the concrete word pool shown in Appendix A, and "A" words are from the abstract word pool. The maximum score for any subject in any cell was 10.

## APPENDIX D

### Analysis of Variance Summary Table for Experiment 1

| Source of Variation | *SS* | *df* | *MS* | *F* |
|---|---|---|---|---|
| Subjects (S) | 87.98 | 15 | 5.87 | |
| Shadowing Condition (A) | .02 | 1 | .02 | .00 |
| A x S | 79.23 | 15 | 5.28 | |
| Stimulus Type (B) | 221.27 | 1 | 221.27 | 94.87** |
| B x S | 34.99 | 15 | 2.33 | |
| A x B | .77 | 1 | .77 | .85 |
| A x B x S | 13.48 | 15 | .90 | |

$^{**}p < .01$

# APPENDIX E

## Concepts Presented for "Animal, Vegetable, Mineral" Classification Task Used in Experiment 2

| | | |
|---|---|---|
| monkey | rhubarb | petunia |
| goose | lava | pecan |
| daffodil | turquoise | rock |
| emerald | grass | lead |
| banana | squash | salt |
| squirrel | sunflower | wheat |
| otter | tiger | tulip |
| mica | giraff | broccoli |
| chicken | goat | rhinoceros |
| peach | artichoke | sheep |
| zinnia | coal | opossum |
| carbon | granite | spinach |
| copper | lime | jade |
| stone | leopard | grape |
| porpoise | bean | toad |
| chinchilla | butterfly | geode |
| crystal | tin | cow |
| plum | corn | sand |
| coyote | iron | cherry |
| pansy | orange | sparrow |
| opal | zebra | orchid |
| hyacinth | camel | slate |
| daisy | clay | lion |
| penguin | mouse | garnet |

APPENDIX F

Recognition Scores for Subjects in Experiment 2

| S# | Tray[a] order | Auditory[b] type order | Adj.[c] P | Adj.[c] W | Prose[d] P | Prose[d] W | A-V-M[e] P | A-V-M[e] W | Totals P | Totals W |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 1 2 | ADJ-AVM-PRO | 12 | 12 | 16 | 12 | 16 | 12 | 44 | 36 |
| 2 | 3 2 1 | AVM-PRO-ADJ | 13 | 13 | 13 | 12 | 14 | 11 | 40 | 36 |
| 3 | 1 2 3 | PRO-AVM-ADJ | 13 | 11 | 15 | 7 | 15 | 9 | 43 | 27 |
| 4 | 3 1 2 | AVM-ADJ-PRO | 16 | 8 | 6 | 9 | 14 | 8 | 32 | 25 |
| 5 | 3 2 1 | PRO-ADJ-AVM | 16 | 16 | 14 | 12 | 16 | 13 | 46 | 41 |
| 6 | 2 1 3 | ADJ-PRO-AVM | 16 | 14 | 14 | 7 | 13 | 6 | 43 | 27 |
| 7 | 2 3 1 | AVM-PRO-ADJ | 16 | 8 | 14 | 9 | 15 | 14 | 45 | 31 |
| 8 | 1 3 2 | ADJ-PRO-AVM | 16 | 12 | 14 | 8 | 12 | 11 | 42 | 31 |
| 9 | 2 1 3 | PRO-ADJ-AVM | 16 | 12 | 16 | 12 | 14 | 11 | 46 | 35 |
| 10 | 3 1 2 | PRO-AVM-ADJ | 15 | 9 | 14 | 8 | 13 | 10 | 42 | 27 |
| 11 | 1 3 2 | AVM-ADJ-PRO | 14 | 9 | 16 | 13 | 14 | 10 | 44 | 32 |
| 12 | 1 2 3 | ADJ-AVM-PRO | 15 | 11 | 15 | 7 | 16 | 13 | 46 | 31 |
| Total | | | 178 | 135 | 167 | 116 | 172 | 128 | 517 | 379 |

a. As indicated in the description of stimulus materials, three equivalent sets were selected. These were arbitrarily numbered 1, 2, and 3. Since there were 12 Ss and 6 possible orders, two Ss were randomly assigned to each possible order.

b. Since there were 12 Ss and 6 possible orders of the 3 auditory types of tasks, two Ss were randomly assigned to each possible order.

c. This was an auditory shadowing task wherein S shadowed both high and low imagery adjectives presented at one second intervals.

d. This was an auditory shadowing task wherein S shadowed a prose selection from the United States Constitution.

e. This was an auditory classification task wherein S heard nouns presented one every two seconds which were either animal, vegetable, or mineral and wherein S was to respond to each auditory word with the class it belonged to.

# APPENDIX G

## Analysis of Variance Summary Table for Experiment 2

| Source of Variation | SS | df | MS | F |
|---|---|---|---|---|
| Subjects (S) | 82.78 | 11 | 7.53 | |
| Type of Shadowing (A) | 18.86 | 2 | 9.43 | 2.05 |
| A x S | 101.14 | 22 | 4.60 | |
| Stimulus Type (B) | 264.50 | 1 | 264.50 | 95.39** |
| B x S | 30.50 | 11 | 2.77 | |
| A x B | 1.58 | 2 | .79 | .19 |
| A x B x S | 90.42 | 22 | 4.11 | |

**p < .01

## APPENDIX H

### Recognition Scores for Subjects in Experiment 3[1]

| | Shadow | | Non-Shadow | | Total |
|---|---|---|---|---|---|
| | Picture | Word | Picture | Word | |
| S1 | 9 | 4 | 8 | 9 | 30 |
| S2 | 9 | 7 | 9 | 9 | 34 |
| S3 | 10 | 0 | 10 | 3 | 23 |
| S4 | 10 | 5 | 10 | 8 | 33 |
| S5 | 9 | 3 | 10 | 5 | 27 |
| S6 | 9 | 2 | 10 | 10 | 31 |
| S7 | 10 | 5 | 10 | 6 | 31 |
| S8 | 9 | 6 | 10 | 4 | 29 |
| S9 | 10 | 5 | 10 | 8 | 33 |
| S10 | 10 | 6 | 10 | 6 | 32 |
| S11 | 9 | 5 | 10 | 6 | 30 |
| S12 | 9 | 6 | 10 | 7 | 32 |
| S13 | 9 | 5 | 10 | 10 | 34 |
| S14 | 10 | 7 | 9 | 6 | 32 |
| S15 | 8 | 3 | 10 | 6 | 27 |
| S16 | 9 | 1 | 8 | 7 | 25 |
| Total | 149 | 70 | 154 | 110 | |

[1]The scores given represent the number correctly identified as "seen before." The maximum cell score possible by a single S is 10.

APPENDIX I

**Analysis of Variance Summary Table for Experiment 3**

| Source of Variation | SS | df | MS | F |
|---|---|---|---|---|
| Subjects (S) | 39.11 | 15 | 2.61 | |
| Shadowing Condition (A) | 31.64 | 1 | 31.64 | 17.19** |
| A x S | 27.61 | 15 | 1.84 | |
| Stimulus Type (B) | 236.39 | 1 | 236.39 | 82.73** |
| B x S | 42.86 | 15 | 2.86 | |
| A x B | 19.14 | 1 | 19.14 | 9.87** |
| A x B x S | 29.10 | 15 | 1.94 | |

**$p < .01$

# APPENDIX J

## Average Reported Confidence Levels in Experiment 3[1]

| | Shadow | | Non-Shadow | |
|---|---|---|---|---|
| | Picture | Word | Picture | Word |
| S1 | 2.1 | 1.1 | 2.7 | 2.5 |
| S2 | 2.4 | 2.3 | 2.9 | 2.7 |
| S3 | 2.4 | .6 | 3.0 | 1.7 |
| S4 | 2.7 | 2.2 | 3.0 | 2.8 |
| S5 | 2.5 | .3 | 3.0 | 1.1 |
| S6 | 2.5 | .7 | 2.9 | 1.9 |
| S7 | 2.9 | 1.9 | 3.0 | 2.2 |
| S8 | 2.4 | 1.0 | 2.9 | 1.5 |
| S9 | 3.0 | 2.0 | 3.0 | 2.6 |
| S10 | 2.7 | .9 | 2.7 | 1.2 |
| S11 | 2.7 | .5 | 3.0 | 1.8 |
| S12 | 2.7 | 1.7 | 2.3 | .9 |
| S13 | 2.3 | 1.6 | 3.0 | 2.4 |
| S14 | 2.5 | 1.3 | 2.6 | 2.2 |
| S15 | 2.4 | 1.2 | 3.0 | 1.9 |
| S16 | 2.5 | 1.1 | 2.8 | 2.3 |

[1] Each S was asked to rate each of his responses as to confidence level. In scoring, arbitrary values were assigned to these confidence levels as follows: 'very sure' = 3, "moderately sure" = 2, "somewhat unsure" = 1, and "just a guess" = 0. Then, the average confidence rating by each S for each cell was calculated.

# APPENDIX K

Analysis of Variance Summary Table for Average

Reported Confidence Levels in Experiment 3

| Source of Variation | SS | df | MS | F |
|---|---|---|---|---|
| Subjects (S) | 525.44 | 15 | 35.03 | |
| Shadowing Condition (A) | 420.25 | 1 | 420.25 | 28.82** |
| A x S | 218.75 | 15 | 14.58 | |
| Stimulus Type (B) | 1849.00 | 1 | 1849.00 | 66.34** |
| B x S | 418.00 | 15 | 27.87 | |
| A x B | 60.06 | 1 | 60.06 | 14.79** |
| A x B x S | 60.94 | 15 | 4.06 | |

**p < .01

# APPENDIX L

## Concepts[1] used in Experiment 4

| | | | |
|---|---|---|---|
| airplane | bread | drum | kite |
| apple | broom | duck | owl |
| apron | bus | elephant | pear |
| arrow | car | eye | pie |
| ball | cat | farmer | pig |
| balloon | chair | fire | radio |
| barn | clock | fish | ship |
| basket | coat | flag | shoe |
| bear | corn | hand | squirrel |
| bed | cow | house | tree |
| bell | cup | key | wagon |
| book | doll | king | window |

[1]Each concept was represented in both word form and as a simple line drawing representation.

APPENDIX M

Recall Scores for Subjects in Experiment 4[1]

| | Shadow | | Non-Shadow | |
|---|---|---|---|---|
| | Picture | Word | Picture | Word |
| S1 | 7 | 4 | 7 | 6 |
| S2 | 5 | 3 | 7 | 7 |
| S3 | 3 | 1 | 5 | 7 |
| S4 | 8 | 2 | 8 | 7 |
| S5 | 4 | 3 | 9 | 7 |
| S6 | 6 | 5 | 9 | 11 |
| S7 | 6 | 6 | 6 | 10 |
| S8 | 2 | 3 | 9 | 5 |
| S9 | 5 | 3 | 6 | 7 |
| S10 | 6 | 3 | 7 | 5 |
| S11 | 5 | 5 | 10 | 10 |
| S12 | 7 | 3 | 6 | 10 |
| S13 | 3 | 2 | 10 | 5 |
| S14 | 2 | 2 | 7 | 7 |
| S15 | 1 | 2 | 8 | 5 |
| S16 | 5 | 4 | 7 | 6 |
| Total | 75 | 51 | 121 | 115 |

[1]The scores given represent the number of concepts correctly recalled. The maximum cell score possible by a single S is 12.

## APPENDIX N

### Analysis of Variance Summary Table for Experiment 4

| Source of Variation | SS | df | MS | F |
|---|---|---|---|---|
| Subjects (S) | 76.93 | 15 | 5.12 | |
| Shadowing Condition (A) | 189.06 | 1 | 189.06 | 96.33** |
| A x S | 29.43 | 15 | 1.96 | |
| Stimulus Type (B) | 14.06 | 1 | 14.06 | 7.16* |
| B x S | 29.43 | 15 | 1.96 | |
| A x B | 5.06 | 1 | 5.06 | 1.63 |
| A x B x S | 46.43 | 15 | 3.09 | |

*p < .05
**p < .01