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Effect of multiple images on associative learning

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The present research investigated the effects of multiple images on associative learning. In Experiment 1, subjects formed either a noninteractive image of two words, a single interactive image, a multiple interactive image consisting of multiple copies of the same image, or a multiple interactive image consisting of different images. In Experiment 2, the different multiple images were formed across trials instead of simultaneously during the same trial. Both experiments showed that, although interactive images are superior to noninteractive images, there is no reliable facilitation from multiple images as compared with single images. The results were discussed in terms of the variable-encoding hypothesis and previous findings that multiple retrieval paths facilitate verbal learning.

The facilitative effects of imagery on memory were known by the ancient Greeks, and laboratory research on imagery was initiated even before the turn of the century (e.g., Kirkpatrick, 1894). This early research and more modern research have shed light on many characteristics of imagery as a mnemonic device for associative learning (for reviews, see Bower, 1970a; Paivio, 1971). For instance, to facilitate learning, the items to be associated should interact in the image rather than be imaged separately (e.g., Bower, 1970b). At least one factor underlying the importance of such interaction is that the interactive image may unitize the to-be-associated items so that one of the items can call forth the other via redintegration (Begg & Robertson, 1973). Another facilitative characteristic is the vividness of the image (see Bower, 1972). Still another facilitative characteristic is the uniqueness of the image (Lesgold & Goldman, 1973).

Just as it is important to know the characteristics of imagery that facilitate memory, so too is it important to know the characteristics that are ineffective, especially when there are a priori reasons for expecting them to be facilitative. For instance, and contrary to the beliefs advocated by some mnemonic textbooks (e.g., Lorayne & Lucas, 1974), the characteristic of bizarreness does not seem to be facilitative (Nappe & Wollen, 1973; Wollen, Weber, & Lowry, 1972; Wortman & Sparling, 1974). Another characteristic that seems to have a negligible effect is the veridicality of the image to a real-world visual scene, as in a photograph. Evidently (and without becoming embroiled in the controversy over the mode of internal representation for a mental image; see Kosslyn, 1975; Pylyshyn, 1973), a mental image should be construed more as a mental layout than as a mental photograph (Neisser & Kerr, 1973; Nelson & Smith, 1972).

The present research continued the goal of delineating the characteristics of imagery that do vs. do not facilitate associative learning. One characteristic that is known to facilitate the free recall retention of a list of words is the formation of multiple retrieval paths in which the words are organized together in different ways, as compared with a single retrieval path in which the words are organized in only one way (Nelson & Hill, 1974). However, multiple retrieval paths are not facilitative if the establishment of the second organization eliminates, perhaps via interference, the first organization (cf. Bower, Lesgold, & Tieman, 1969). Thus, multiple organizations are facilitative, but only when they are established in such a way that they are all intact at the start of the retention interval. One possible explanation underlying the facilitative effect of multiple retrieval paths is that each retrieval path provides a separate route to a given target item; this variable-encoding hypothesis has also been suggested as an explanation for the repetition-lag effect in free recall (Madigan, 1969; Melton, 1970; also see Hintzman, 1974).

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Extrapolating from the situation in free recall, perhaps learning is facilitated more by multiple images than by a single image. Two experiments were conducted to explore the effects of multiple images on associative learning. In the first experiment, the subject was instructed to form all of the multiple images for a given word pair at the same time (i.e., on a single trial), whereas in the second experiment the subject was instructed to form the different images at different times (i.e., across trials).

EXPERIMENT 1

In addition to the multiple-image conditions, two standard single-image conditions were included. One single-image group was instructed to form a noninteractive image for each word pair (e.g., an image of a boot on one side of the room and a chair on the other side of the room, as illustrated in the upper left panel of Figure 1). The second single-image group was instructed to form a single interactive image for each word pair (e.g., an image of a boot standing on a chair, as illustrated in the upper right panel of Figure 1). One multiple-image group was instructed to form a homogeneous multiple image of the same interaction for a given word pair, not unlike the multiplexing that occurs in a kaleidoscopic image (e.g., a multiple image in which each component image consists of a boot standing on a chair, as illustrated in the lower left panel of Figure 1). The other multiple-image group was instructed to form a heterogeneous multiple image of different interactions for a given word pair (e.g., a multiple image in which one component image consists of a boot balancing on a chair, another component image consists of a boot standing on a chair, and still another component image consists of a boot lifting a chair, as illustrated in the lower right panel of Figure 1).

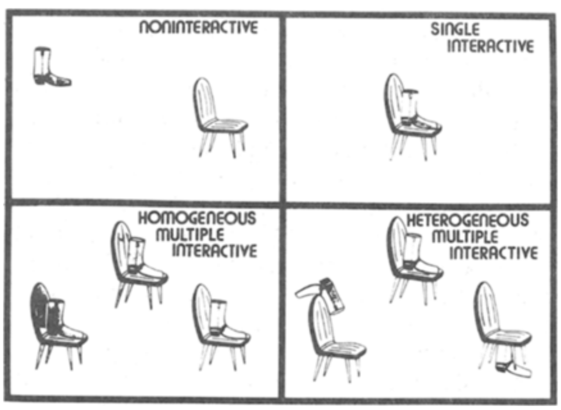

Figure 1. Example of the kind of image that could be formed for the word pair BOOT-CHAIR in each of the four conditions (noninteractive image, single interactive image, homogeneous multiple interactive image, and heterogeneous multiple interactive image).

Table 1
Mean Number of Words Correctly Recalled and Standard Error of the Mean for Each Group in Experiment 1

	Group			
			Multiple Interactive	
Measure	Noninteractive	Single Interactive	Homogeneous	Heterogeneous
Mean*	13.6	23.4	23.6	21.8
SE	1.3	1.2	.9	1.0

**Out of 30 possible.*

Method

Design and Subjects. The only independent variable (between subjects) was the type of imagery instructions, consisting of the four conditions described above (i.e., single noninteractive image, single interactive image, homogeneous multiple image, and heterogeneous multiple image). The subjects were 104 undergraduates from the University of California, Irvine, whose participation earned them extra course credit. They were assigned to the four equal-sized imagery-instruction groups in terms of order of appearance at the laboratory, and the 26 subjects in a given group were run in two subgroups of 13 subjects each. None of the subjects had ever participated in an imagery experiment.

Procedure. The subjects entered a large room where the experimenter explained the learning task and provided instructions about the imagery technique that the subjects were to use. A pictorial example from Figure 1 was shown for the word pair BOOT-CHAIR (cf. Wollen & Lowry, 1974). The subjects tried the technique on the word pair HAMMER-TABLE, after which a pictorial example for that word pair was shown and any questions were answered. Then the subjects were escorted to individual cubicles and seated at a desk with headphones. Each subject heard the study list of 30 word pairs at a rate of one pair every 15 sec, with the stimulus word presented to the left ear and the response word immediately following in the right ear. Then the test trial occurred at the same rate, and subjects wrote their responses in a test booklet.

Apparatus and Items. The apparatus consisted of a Realistic 9098 stereo tape recorder and 13 sets of Sennheiser HD 414 stereo headphones. The tape contained 30 pairs of nouns chosen from the Paivio, Yuille, and Madigan (1968) norms. The nouns were (1) high in imagery value (5.63 or greater in the norms), (2) monosyllabic, (3) unitary so that each could be imaged as a single unit (e.g., tree but not forest), and (4) selected with an attempt being made to avoid related words or polysemous words.

Results and Discussion

The mean number of words correctly recalled, along with the standard error of the mean, is shown for each group in Table 1. The differences among the four means were analyzed by three planned orthogonal comparisons. The first comparison showed that there was no reliable difference between the homogeneous multiple-interactive group and the heterogeneous multiple-interactive group [$F(1,100) = 1.27$, $p > .25$]. The second comparison showed that there was no reliable difference between the single-interactive group and the two multiple-interactive groups taken together [$F(1,100) < 1$]. The third comparison, however, showed that recall was significantly higher for the three interactive groups taken together than for the noninteractive group [$F(1,100) = 53.62$, $p < .001$]. Thus, these results replicate the standard finding that interactive imagery facilitates associative learning more than noninteractive imagery. However, of primary importance, multiple interactive images were no more facilitative than single interactive images, regardless of whether the multiple interactive images were homogeneous or heterogeneous. The multiple-image subjects reported that, although they were able to form multiple images, it was a demanding task. The present results suggest that the extra effort required to form multiple images is not compensated by extra recall.

EXPERIMENT 2

In the previous experiment, the subjects in the multiple-image groups were instructed to simultaneously form all of the component images comprising a given multiple image, and this yielded no advantage over the single-interactive group. Because of the potential import for the variable-encoding hypothesis (Madigan, 1969; Melton, 1970) and because of related previous research showing an advantage of multiple retrieval paths over a single retrieval path (Nelson & Hill, 1974), Experiment 2 was designed to explore further the possibility that multiple interactive images might, at least under some circumstances, be more facilitative than a single interactive image. Instead of instructing the subjects to form the different images simultaneously (as in Experiment 1), in this experiment the subjects were instructed to form the different images across two learning trials. Furthermore, the different images were to consist not only of different interactions (as in Experiment 1), but also of different exemplars of the two words in each word pair. For instance, as shown in Figure 2 for the word pair BOOT-CHAIR, the image to be formed on the first trial might consist of a cowboy boot standing on a straight-backed chair, whereas the image to be formed on the second trial might consist of a hiking boot kicking a stuffed chair. This change in the exemplars (originally suggested by an anonymous reviewer), along with the change in the mode of interaction, was designed to make the encodings in the different-image condition even more variable in Experiment 2 than they were in Experiment 1.

Method

Design. The independent variable (between subjects) was the type of imagery instructions, consisting of three conditions. One group was instructed to form a noninteractive image for each word pair (e.g., an image of a boot on one side of the room and a chair on the other side of the room). The second group was instructed to form an interactive image for each word pair and to form the same interactive image on both study-test trials (e.g., an image of a boot standing on a chair during every trial). The third group was instructed to form a different interactive image on each of the two study-test trials for a given word pair (e.g., as shown in Figure 2).

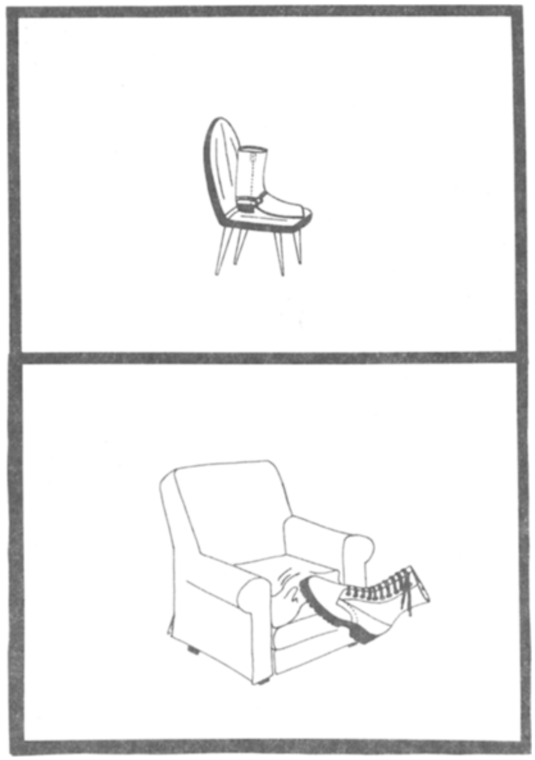

Figure 2. Example of two kinds of images that could be formed for the word pair BOOT-CHAIR in the different-interactive condition.

Subjects. The subjects, run in small subgroups of 8 to 13, were 94 undergraduates from the University of Washington whose participation earned them extra course credit. They were assigned to the three groups in terms of their order of appearance at the laboratory, and the eventual group sizes were $n = 33$ for the noninteractive group, $n = 31$ for the same-interactive group, and $n = 30$ for the different-interactive group.

Procedure. The procedure was the same as that from Experiment 1 except for the following changes: (1) The instructions were changed in accord with the design described above; (2) instead of being in individual cubicles and wearing headphones, the subjects were run in a large room and did not wear headphones; (3) pilot research indicated that a 10-sec presentation rate for both study and test was sufficiently slow, so this rate was employed in the main experiment; and (4) the list length was increased from 30 to 100 word pairs.[1]

Apparatus and Items. The items were presented over speakers via a Sony TC-126 stereo tape recorder; each stimulus word was presented from the left speaker and each response word was presented from the right speaker. The items were from a pool similar to that used in Experiment 1. However, because of the restrictions imposed, 200 nouns (for the 100 word pairs) were not available in the Paivio et al. (1968) norms. Consequently, we selected a large set of common nouns from the Thorndike-Lorge norms and subjected them to the imagery-rating procedure of Paivio et al., with 15 raters from the same population as used for the eventual subjects. The only changes from the Paivio et al. procedure were: (1) we used an 8-sec auditory presentation rate whereas Paivio et al. used a "fairly quickly" self-paced visual presentation rate and (2) the raters recorded their ratings on a computer-scorable response sheet rather than in a response booklet. The final set of 100 word pairs consisted of 200 nouns that were: (1) high in imagery value (5.27 or greater), (2) monosyllabic or bisyllabic, (3) unitary so that each noun could be imaged as a single unit, and (4) selected with an attempt being made to avoid related words or polysemous words.

Results and Discussion

The mean number of words correctly recalled, along with the standard error of the mean, is shown for each group on each trial in Table 2. The results from each trial were analyzed by two planned orthogonal comparisons: (1) same interactive vs. different interactive and (2) the two interactive conditions vs. the noninteractive condition. For the first trial, the latter comparison was expected to be significant, but no significant effect was expected for the former comparison (because subjects in the two interactive conditions were instructed to do the same processing on the first trial; differential processing across the two interactive groups was not to occur until the second trial). The Trial 1 results confirmed the above. There was no reliable difference between the two interactive groups [$F(1,91) < 1$], but these two groups taken together did have reliably higher recall than the noninteractive group [$F(1,91) = 34.69$, $p < .001$]. The advantage of instructions to form interactive images over instructions to form noninteractive images replicates the results both from Experiment 1 and from previous research (e.g., Bower, 1970b).

The crucial data concern the results from the second trial (shown in the bottom row of Table 2). Not surprisingly, recall was reliably lower for the noninteractive group than for the two interactive groups [$F(1,91) = 27.58$, $p < .001$]. Of primary importance, however, there was no reliable difference between the same-interactive group and the different-interactive group [$F(1,91) < 1$]; in fact, the sample means actually were identical to the first decimal place (see Table 2). Similar to Experiment 1, the different-interactive subjects reported that, although they were able to form different interactive images for each word pair across the two trials, it was a somewhat demanding task. Apparently, the extra effort (relative to that expended by the same-interactive subjects) is not compensated by extra recall.

Table 2
Mean Number of Words Correctly Recalled and Standard Error of the Mean on Each Trial for Each Group in Experiment 2

	Group					
			Interactive			
	Noninteractive		Same		Different	
Trial	Mean	SE	Mean	SE	Mean	SE
1	21.0	2.9	45.2	3.9	45.3	3.4
2	53.8	4.2	79.2	4.1	79.2	3.6

Note–Maximum possible recall was 100.

CONCLUSIONS

Almost everyone benefits from instructions to use mental imagery during learning (Marks, 1972), even congenitally blind people (Jonides, Kahn, & Rozin, 1975). Extra energy potentially could be expended to form multiple images instead of single images, or to concoct different images instead of maintaining the same images. The results of the present experiments suggest that such imagery techniques yield no extra advantage for associative learning; the crucial operation seems to be the formation of interactive images.

A number of factors that are known to have strong effects on verbal processing seem to have negligible effects on imagery processing (e.g., auditory interference in Atwood, 1971). The present results suggest that this list of factors can be expanded to include variable encoding and multiple retrieval paths, which failed to yield any reliable influence on the recall of associations formed via imagery instructions.

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NOTE

1. A previous variant of Experiment 2 using only 30 word pairs yielded the same qualitative conclusions as the present Experiment 2 but was marred by a possible ceiling effect on the second study-test trial. Subsequent pilot research on 50 word pairs also yielded a possible ceiling effect. Still more pilot research on 100 word pairs finally yielded performance that was well below the ceiling on the second study-test trial, so this list length was employed in the main experiment.

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