THE NATURE OF THE STIMULUS, PROVIDING MEDIATORS, AND PAIRED-ASSOCIATE LEARNING

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ABSTRACT

THE NATURE OF THE STIMULUS, PROVIDING MEDIATORS, AND PAIRED-ASSOCIATE LEARNING

by Martin Bolt

Although subjects report using mediators for learning a paired-associate list, there is little convincing evidence that mediators actually facilitate paired-associate learning. The present study was designed to test the hypothesis that providing mediators will facilitate the learning of a paired-associate list. A second hypothesis was that the extent of the facilitation depends on the nature of the stimulus.

A 3 x 3 factorial design was utilized in which the first variable was the nature of the stimulus (trigram, bigram, or single letter) and the second variable was the appropriateness of the mediator (relevant mediator, irrelevant mediator, or no mediator). Varying the nature of the stimulus was expected to influence the mediators which the control subjects would discover and utilize, and thereby affect the amount of facilitation obtained by providing subjects with mediators. A separate group was used for each of the nine conditions with each group receiving a different paired-associate

list. The study-test method of presentation was utilized; the stimuli, mediators for mediation groups, and responses were presented on the study trials, and only the stimuli appeared on the test trials.

Both the nature of the stimulus and the appropriateness of the mediator significantly influenced performance. The interaction was not significant. Providing subjects with relevant mediators facilitated their learning a paired-associate list while providing irrelevant mediators had a deleterious effect. Performance improved as the number of letters in the stimulus increased. The reason for the failure to obtain the interaction was not clear. Since the nature of the stimulus influenced the number of mediators reported by the control subjects but not by the subjects provided relevant mediators, it seems apparent, at least with the present materials, that this measure is not necessarily directly related to paired-associate learning.

Approved Gordon Ward

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INTRODUCTION

There is some evidence that Ss learning paired-associate (P-A) lists utilize mediators or mnemonic devices for at least some of the items. But there is little convincing evidence that mediators or mnemonic devices actually facilitate P-A learning. Bugelski (1962) found that Ss reported the use of mediators for 67% of the paired-associates and that many Ss reported inability to learn particular pairs until they were able to provide mediators for these pairs. Runquist and Farley (1964) instructed Ss to produce verbal mediating responses for particular pairs of items and measured the latencies of their response. The assumption was made that the strength of the mediator would be reflected in its latency. Therefore, if a mediator had been used for learning a particular pair, the latency of reporting a specific mediator should be quite short as compared with the latency of report when a mediator was not used in learning. They found that learning the P-A list prior to the "mediation test" decreased the latency of the reported mediators and that the latency of mediators was shorter for those items on which S reported using a mediator during learning.

The above evidence, although suggesting that mediators may facilitate P-A performance, is not sufficient because, as Underwood and Schulz (1960) suggest, Ss may simply report using mediators on the items they learn most rapidly. Another approach, which does not rely on the reports of S, may be more appropriate for ascertaining the role of mediators in P-A learning. A study by Dallett (1964) suggests a possible alternative. Dallett attempted to alter S's associative responses to stimulus trigrams by presenting a word during the first presentation trial which was an associate of the trigram and either related or unrelated to the response which S was to learn. For example, the word bacon (relevant mediator) or back (irrelevant mediator) was presented in parentheses between the trigram bac and response eggs. Dallett found that if a relevant association was primed, S learned faster than if an irrelevant association was primed. However, a control group presented only the trigrams and responses did not differ significantly in performance from the groups receiving relevant mediators. The failure to obtain a significant difference might suggest that providing mediators does not facilitate P-A learning. However, Dallett suggested that the relevant mediating associations were available without priming for control group Ss, and therefore control Ss were also using

mediators. For example, in learning the P-A item bac-eggs, control Ss may have discovered and utilized the mediator bacon. It seems plausible that providing mediators for one group will not facilitate their learning unless the control group is unable to discover or utilize the same or comparable mediators. That is, if control Ss are not able to discover and utilize effective mediators, providing Ss with effective mediators should facilitate P-A learning. Two hypotheses were investigated in the present study. The first hypothesis was that providing mediators can facilitate the learning of a P-A list. The second hypothesis was that the nature of the stimulus will influence the mediators which control Ss discover and utilize, and thereby affect the amount of facilitation obtained by providing Ss with mediators. Thus, there should be an interaction between the nature of the stimulus and the mediation treatment in that the nature of the stimulus should not influence the number of mediators available to those Ss provided with mediators.

METHOD

Design. A 3 x 3 factorial design was utilized. The first variable was the nature of the stimulus (trigram, bigram, or single letter), and the second variable was the appropriateness of the mediator (relevant mediator, irrelevant mediator, or no mediator). The assumption was made that varying the nature of the stimulus would influence the likelihood of control Ss discovering a "relevant" mediator. For example, the mediator bacon should be more easily discovered if the stimulus-response Bac-eggs is presented than if B-eggs is presented. The irrelevant mediation condition was included to control for the possibility that the mediator may simply serve as a better functional stimulus. One could argue that facilitation is obtained by presenting a mediator simply because it is easier to associate a word with a word than a word with a trigram, bigram, or single letter. Thus, if facilitation results when a "mediator" not related to the correct response is provided, then the facilitation obtained by providing a relevant mediator probably results from S using a word as the functional stimulus rather than the trigrams, bigrams, or single letters. That is, if a pre-established

association between the "mediator" and response is not necessary in order to obtain facilitation, then it is probably more appropriate to say that the S has used a different functional stimulus (i.e., the mediator) than to say that the S has mediated.

A separate group of Ss was used for each of the nine conditions with each group receiving a different P-A list. The prediction was that the relevant groups would do better than the irrelevant groups and that the performance of the controls, that is, those groups presented no mediators, would fall between these two groups. Furthermore, for the control group presented the trigrams, a relevant mediator should be more easily discovered than for the control groups presented the bigrams or single letters. Thus, an interaction was expected such that there should be a greater difference in performance between the single letter control and single letter relevant groups than between the trigram control and trigram relevant groups.

Materials. Three of the nine lists utilized in the experiment are presented in Table 1. Each list had the same stimulus trigrams and responses. The lists differed with respect to whether no mediator was presented, a relevant mediator was presented, or an irrelevant mediator was presented. The six additional lists were identical to the three lists in Table 1 except for the

Table 1. Lists for the three conditions having a relevant, irrelevant, or no mediator and trigrams as stimuli

Relevant Mediator	Irrelevant Mediator	Control
WEV CLOTH (WEAVE)	WEV CLOTH (WEATHER)	WEV CLOTH
TAL POWDER (TALCUM)	TAL POWDER (TALENT)	TAL POWDER
YAR SEASON (YEAR)	YAR SEASON (YARN)	YAR SEASON
RUJ LIPSTICK (ROUGE)	RUJ LIPSTICK (RUG)	RUJ LIPSTICK
BAC EGGS (BACON)	BAC EGGS (BACK)	BAC EGGS
KAF SYRUP (COUGH)	KAF SYRUP (CALF)	KAF SYRUP
DEP SHERIFF (DEPUTY)	DEP SHERIFF (DEPTH)	DEP SHERIFF
MOD SAD (MOOD)	MOD SAD (MODE)	MOD SAD
PIC BASKET (PICNIC)	PIC BASKET (PICTURE)	PIC BASKET
SAV MONEY (SAVE)	SAV MONEY (SAVAGE)	SAV MONEY
LUN FOOD (LUNCH)	LUN FOOD (LUNATIC)	LUN FOOD
HAR SOFT (HARD)	HAR SOFT (HARM)	HAR SOFT

stimuli. That is, the bigram lists were identical to the trigram lists except for the deletion of the last letter from each trigram. The three single letter lists were identical to the three trigram lists except for the deletion of the last two letters from each trigram.

The nine lists were typed on memory drum tapes, similarly to the way they are presented in Table 1, with each list appearing in three different orders. That is, for the six lists containing mediators, the stimulus was on the left, the mediator in parentheses immediately below the stimulus, and the response immediately to the right of the stimulus. For the three lists containing no mediators, the stimulus was to the left and the response was to the right.

Procedure. The study-test method of presentation was employed with the stimuli, mediators for mediation groups, and responses being presented on the study trials. Only the stimuli appeared on the test trials. Throughout the experiment the memory drum was operated at a 2 sec. rate with a 4 sec. intertrial interval. Criterion was set at one errorless test trial or a maximum of six alternating study and test trials.

The nine groups were given the same instructions for P–A learning. However, in addition to the instructions given the controls, the mediation groups were

told that there would be a word in parentheses below each stimulus which should help them associate or connect the stimulus on the left with the response on the right.

After the last trial the drum was stopped and S was given a list of the 12 pairs that had just been presented. At the top of the list were instructions to write, next to each pair, any mediators, mnemonic devices, or memory tricks that he had used in learning the pairs.

Subjects. The Ss were 135 undergraduate students enrolled in introductory psychology courses at Michigan State University. They were randomly assigned to one of the nine groups, each group consisting of fifteen subjects.

RESULTS

The mean number of correct responses for the six test trials is presented in Table 2. Subjects reaching criterion prior to the sixth test trial were given a score of 12 correct on each of the remaining test trials. For any given stimulus condition the group provided a relevant mediator was consistently superior both to the group not given a mediator and to the group provided an irrelevant mediator. In addition, each group not presented a mediator was consistently superior to the corresponding group provided an irrelevant mediator. Each group presented trigrams as stimuli did better than the corresponding group presented bigrams, and in turn each group presented bigrams was superior to the corresponding group presented single letters.

An analysis of variance was conducted on the number correct for the first trial, the first two trials, the first three trials, and all six trials. Since all of these analyses yielded essentially the same results, the analysis of the number correct for the first trial will be reported so that comparisons can be made between the present study and the study by Dallett. This analysis indicated, as expected, that the nature of the stimulus

Table 2. Mean number of correct responses on each trial for each condition

			Trials					
			1	2	3	4	5	6
Single Letter	R	M	3.20	7.47	8.87	9.60	10.80	10.86
		SD	2.69	4.86	4.85	4.11	3.11	3.46
	C	M	2.33	4.80	6.73	7.86	8.27	9.00
		SD	2.56	4.29	5.58	8.06	5.61	8.66
	IR	M	1.20	3.20	5.27	6.07	7.00	7.47
		SD	2.29	2.42	7.49	7.89	10.33	8.86
Bigram	R	M	3.93	7.80	9.13	10.27	10.27	10.80
		SD	2.53	4.56	5.11	2.40	4.80	2.29
	C	M	2.93	6.53	8.47	9.60	10.27	10.40
		SD	3.99	4.76	3.79	3.30	2.27	3.84
	IR	M	1.27	4.73	6.33	7.93	8.60	9.73
		SD	1.53	3.03	4.26	5.98	5.17	4.53
Trigram	R	M	8.13	10.80	11.40	12.00	12.00	12.00
		SD	4.03	1.36	1.17	0.00	0.00	0.00
	C	M	6.07	9.93	11.13	11.87	11.87	11.93
		SD	1.63	1.33	1.25	0.18	0.18	0.15
	IR	M	3.47	6.80	9.00	10.47	10.60	11.33
		SD	5.96	8.43	6.27	3.65	5.71	4.90

and providing mediators were both significant sources of variance yielding Fs (2,126) of 34.13 and 55.02, $p < .001$, respectively. The interaction was not significant, F (4,126) = 2.26, $p > .05$. The failure to obtain the interaction was not as expected since it was predicted that the trigram control group would have an easier time discovering mediators than the single letter control group, but little difference was expected between the single letter and trigram groups provided mediators.

Although Dallett failed to find a significant difference between the control and relevant groups, a significant difference between the trigram relevant and trigram control groups was obtained in the present study, F (1,28) = 10.53, $p < .01$. The fact that the present study did demonstrate that P-A performance can be facilitated by providing subjects with relevant mediators may be attributable to the methodological differences between the two studies.

Each S in the trigram and bigram relevant groups reported using all twelve mediators provided by E. The mean number of mediators that the Ss in the single letter relevant group reported was 11.67 with all of the mediators reported being those provided by E. The mean number of mediators reported by the trigram, bigram, and single letter irrelevant groups was 7.40, 8.93, and

8.60 respectively, with 86%, 92%, and 90% of the mediators reported by each of these groups respectively, also being the ones provided during the study trials. The mean number of mediators reported by the trigram, bigram, and single letter control groups was 8.80, 6.13, and 5.00. An analysis of variance indicated that there was a significant difference in the number of mediators reported by the three control groups, $F(2,42) = 4.33$, $p < .05$. This finding would seem to indicate that the nature of the stimulus does affect the number of mediators reported. However, whether all Ss utilized the mediators they reported is questionable. For example, it is quite possible that the groups provided with irrelevant mediators reported using these mediators merely because they had been told to do so. Yet, if one assumes that Ss actually utilized the mediators they reported, then the superior performance, relative to the controls, of the groups provided relevant mediators and the inferior performance of groups provided irrelevant mediators would have to be accounted for on the basis of the efficiency and not necessarily the number of mediators reported. That is, the control groups reported using the fewest mediators; yet their performance was consistently superior to that of the irrelevant groups. This finding indicates that either some qualitative distinction between mediators should

be made or that the number of mediators reported is not necessarily related to performance. Possibly the mediators discovered by the control groups were more effective than the irrelevant mediators in that the former more readily elicited the correct response.

DISCUSSION

The results clearly indicate that providing subjects with a relevant mediator facilitates their learning a P-A list, whereas providing an irrelevant mediator has a deleterious effect. The fact that each control group was superior to its corresponding irrelevant group indicates that providing a "mediator" not having a pre-established connection with the response interferes with learning. It seems necessary that there be a strong connection between the mediator and the response in order for the mediator to facilitate P-A learning.

Manipulation of the stimulus also led to a significant difference in performance. In varying the stimulus it was assumed that the likelihood that control Ss would discover a "relevant" mediator was also being manipulated. That is, with an additional letter in the stimulus the likelihood of a control S discovering a relevant mediator should be increased. It was predicted that the increased likelihood of discovering relevant mediators should be reflected in a significant interaction between the main effects. The fact that control Ss given trigrams as stimuli reported more mediators than the control Ss given single letters as

stimuli does suggest that they were able to discover more mediators. Yet, since having a trigram as a stimulus rather than a single letter or bigram did not produce a differential facilitation for control Ss as compared to Ss provided with relevant mediators, the prediction was not supported. Perhaps having a trigram for a stimulus enabled control Ss to discover more mediators and to utilize them effectively. Yet, if Ss provided with mediators were able to utilize them more effectively when they were given trigrams rather than bigrams or single letters as stimuli then there should be little reason to expect an interaction between providing mediators and the nature of the stimulus.

Although Dallett failed to find a significant difference between the control and relevant groups, a significant difference was obtained between the comparable groups (i.e., trigram relevant and trigram control) of the present study. The difference in the results obtained by the two studies may be attributable to the different methods or to the presentation rate. Dallett used the anticipation method and a 2:1 rate of presentation while the study-test method and a 2 sec. rate of presentation was employed in the present study. Particularly in regard to the presentation of mediators, the use of the study-test method may be advantageous. That

is, the results of the present study indicate that providing a mediator will have the greatest facilitative effect on P-A learning when a strong association exists not only between the stimulus and the mediator but also between the mediator and the response. The strengthening of the connection between the mediator and the response was likely to occur in the present study in that the stimulus, mediator, and response were presented together for 2 sec. during the study trial. In the Dallett study the stimulus and mediator were presented for 2 sec. prior to the presentation of the stimulus, mediator, and response for a 1 sec. period. Obviously, the present study does not afford evidence regarding why providing mediators facilitated performance in the present study and priming mediators did not produce significant facilitation in the Dallett study. It is highly likely, however, that presentation rate or presentation method was responsible for the differences obtained because identical materials were used in the two studies.

SUMMARY

One hypothesis for the present study was that providing Ss with mediators would facilitate their learning a P-A list. A second hypothesis was that the extent of the facilitation would depend on the nature of the stimulus.

A 3 x 3 factorial design was utilized with the first variable being the nature of the stimulus (trigram, bigram, or single letter) and the second variable the appropriateness of the mediator (relevant mediator, irrelevant mediator, or no mediator). The assumption was made that varying the nature of the stimulus would influence the likelihood of control Ss discovering a "relevant" mediator. The irrelevant mediation condition was included to control for the possibility that a mediator may simply serve as a better functional stimulus. The study-test method of presentation was employed, with the stimuli, mediators, and response being presented on the study trials and only the stimuli appearing on the test trials.

Both the nature of the stimulus and appropriateness of the mediator produced reliable effects. The results clearly indicated that providing Ss with

relevant mediators facilitated their learning a P-A list while providing irrelevant mediators had a deleterious effect. The expected interaction between the nature of the stimulus and the appropriateness of the mediator was not obtained. The reason for the failure to obtain the interaction was not clear. Since the nature of the stimulus influenced the number of mediators reported for the control Ss but not for the Ss provided relevant mediators, it seems apparent that at least with the present materials this measure is not necessarily directly related to P-A learning.

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APPENDIX A

NUMBER CORRECT ON EACH TRIAL FOR EACH SUBJECT

SINGLE LETTER RELEVANT GROUP

Subjects	Trials 1	2	3	4	5	6
1	2	6	10	11	11	12
2	5	10	11	11	12	12
3	2	4	8	7	8	8
4	0	6	9	10	12	12
5	5	11	12	12	12	12
6	4	6	4	6	9	9
7	5	7	8	9	7	10
8	1	10	9	11	12	12
9	5	10	10	12	12	12
10	1	4	4	5	8	6
11	4	9	10	10	12	12
12	4	8	10	9	12	12
13	2	5	9	10	12	12
14	4	7	8	10	11	10
15	4	9	11	11	12	12

SINGLE LETTER CONTROL GROUP

Subjects	Trials 1	2	3	4	5	6
1	2	5	6	8	9	11
2	0	4	7	10	10	12
3	1	2	2	3	3	3
4	4	9	10	11	11	11
5	4	3	5	7	8	9
6	3	5	7	9	9	11
7	2	3	3	2	4	3
8	6	8	10	10	9	9
9	1	2	6	7	7	10
10	2	7	10	11	11	12
11	1	4	8	10	11	8
12	1	5	5	6	6	7
13	1	3	6	4	7	6
14	4	5	7	10	10	11
15	3	7	9	10	9	12

SINGLE LETTER IRRELEVANT GROUP

Subjects	Trials 1	2	3	4	5	6
1	3	5	11	11	11	11
2	1	1	2	2	4	4
3	1	2	4	4	4	7
4	1	4	6	7	9	8
5	2	5	8	9	11	10
6	0	2	4	2	2	4
7	1	3	3	5	5	4
8	6	4	8	9	10	11
9	0	3	3	4	2	3
10	1	3	8	10	11	10
11	0	4	3	4	4	3
12	0	2	4	6	8	10
13	0	0	1	3	4	7
14	1	6	6	7	10	10
15	1	4	8	8	10	10

BIGRAM RELEVANT GROUP

Subjects	Trials 1	2	3	4	5	6
1	6	9	10	10	9	9
2	3	3	4	8	5	9
3	3	9	12	12	12	12
4	4	8	10	12	12	12
5	0	6	7	9	8	9
6	7	11	12	12	12	12
7	4	11	12	12	12	12
8	4	7	11	11	12	12
9	4	5	8	11	11	11
10	5	9	9	11	12	12
11	5	10	11	11	11	11
12	2	7	7	7	6	7
13	3	6	7	8	10	11
14	5	8	9	10	11	11
15	4	8	8	10	11	12

BIGRAM CONTROL GROUP

Subjects	Trials 1	2	3	4	5	6
1	2	4	7	10	11	12
2	4	7	8	8	10	10
3	5	10	11	10	10	12
4	3	9	7	11	11	12
5	2	8	9	11	12	12
6	6	10	12	12	12	12
7	2	5	7	8	8	7
8	1	5	9	12	12	12
9	5	6	8	9	10	8
10	1	3	5	7	8	8
11	4	4	9	10	9	9
12	0	4	6	6	8	7
13	0	5	8	8	9	11
14	6	10	12	12	12	12
15	3	8	9	10	12	12

BIGRAM IRRELEVANT GROUP

Subjects	Trials 1	2	3	4	5	6
1	1	2	4	8	8	12
2	2	5	4	6	7	8
3	0	4	5	5	6	7
4	0	5	7	9	8	10
5	0	4	4	7	4	7
6	1	3	6	10	8	11
7	2	4	6	10	9	8
8	1	5	8	7	10	12
9	1	4	5	5	8	6
10	2	4	4	3	6	8
11	1	4	6	7	9	10
12	2	4	8	9	10	11
13	0	6	9	11	12	12
14	5	9	11	12	12	12
15	1	8	8	10	12	12

TRIGRAM RELEVANT GROUP

Subjects	Trials 1	2	3	4	5	6
1	11	12	12	12	12	12
2	9	11	12	12	12	12
3	8	11	12	12	12	12
4	8	9	11	12	12	12
5	7	8	8	12	12	12
6	10	10	12	12	12	12
7	6	10	11	12	12	12
8	6	11	11	12	12	12
9	11	12	12	12	12	12
10	4	12	12	12	12	12
11	6	11	12	12	12	12
12	8	12	12	12	12	12
13	10	10	10	12	12	12
14	10	12	12	12	12	12
15	8	11	12	12	12	12

TRIGRAM CONTROL GROUP

Subjects	Trials 1	2	3	4	5	6
1	7	12	12	12	12	12
2	6	9	12	12	12	12
3	6	9	10	12	12	12
4	9	10	11	12	12	12
5	6	12	12	12	12	12
6	6	10	9	10	10	11
7	6	9	12	12	12	12
8	5	9	12	12	12	12
9	4	8	11	12	12	12
10	5	10	11	12	12	12
11	7	11	12	12	12	12
12	4	9	10	12	12	12
13	6	10	9	12	12	12
14	6	11	12	12	12	12
15	8	10	12	12	12	12

TRIGRAM IRRELEVANT GROUP

Subjects	Trials 1	2	3	4	5	6
1	1	2	3	5	3	6
2	8	11	12	12	12	12
3	6	11	11	12	12	12
4	3	5	9	11	12	12
5	1	3	7	9	10	11
6	2	10	12	12	12	12
7	3	6	10	11	11	12
8	4	7	10	12	12	12
9	3	6	8	11	10	9
10	6	9	10	12	12	12
11	2	5	9	10	12	12
12	1	4	6	9	8	12
13	4	9	10	11	12	12
14	8	10	12	12	12	12
15	0	4	6	8	9	12