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# FACILITATION OF PAIRED-ASSOCIATE LEARNING BY NON-VERBAL MEDIATORS[1]

P. E. FREEDMAN[2] AND NAN E. MC GEHEE
*U.S. Army Natick Laboratories* *University of Illinois at Chicago Circle*

*Summary.*—80 *Ss* divided into 4 groups received paired-associate training under 1 of 4 mediational paradigms: stimulus equivalence, response equivalence, and 2 chaining paradigms. Different intensities of shock and tone were used as non-verbal mediators with each of 6 CVC pairs. Three other pairs were used as non-mediated controls. The use of non-verbal mediators facilitated paired-associate learning and the degree of facilitation was a direct function of the intensity of the mediators. Neither paradigms nor type of mediator were effective variables.

Studies of mediation in paired-associate learning have almost universally used verbal stimuli as mediators. These studies have typically investigated one or more of three paradigms. The first is the "chaining" paradigm in which Phase I learning establishes an A-B association, Phase II learning establishes a B-C association and Phase III learning is the A-C mediation test. An alternate "chaining" paradigm consists of B-A, C-B, A-C training. A second paradigm is the "stimulus equivalence sequence." In this arrangement Phase I consists of A-B learning, Phase II of C-B learning and Phase III of the A-C mediation test. The third paradigm is the response equivalence arrangement. In this case Phase I learning consists of B-A learning, Phase II of B-C learning and Phase III of the A-C mediation test. Much of this research has used free-association norms as a basis for inferring Phase III performance. But, even when the research required that the mediator be established in the experimental setting, thereby presenting an opportunity to select a non-verbal mediational response, only verbal items have been used. The purpose of the present research is to test the efficacy of non-verbal mediators and to investigate stimulus intensity as a mediational variable. Three different levels of shock and three different tone intensities served as mediational stimuli.

## METHOD

### *Subjects*

Eighty male undergraduates at Northeastern University served as *Ss*. They were paid and volunteered with the knowledge that they might receive harmless electric shock.

### *Verbal Materials and Mediators*

The 9 stimuli and 9 responses were CVC nonsense syllables with Krueger

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[2]Now at the University of Illinois at Chicago Circle.

Association Values between 44 and 95, with a mean of 74. They were selected for high pronunciability ratings ($M = 3.52$, range = 2.65 to 4.89; Underwood & Schulz, 1960) and low inter- and intra-pair formal similarity. The same stimulus and response were always paired and the nine pairs were the same for each *S*. A mediator was assigned to each of six of the pairs, and three different S-R pair-mediator combinations were used. The mediators were strong shock (ss), medium shock (ms), weak shock (ws), strong tone (st), medium tone (mt) and weak tone (wt). Three pairs had no mediator and were designated control pairs (oo).

*Procedure*

*Ss* were randomly assigned to one of four groups of 20 *Ss* each. All groups went through three phases. Phase I involved stimulus familiarization coupled with a mediator (M). Phase II involved response familiarization coupled with a mediator, and Phase III involved paired-associate learning of the stimulus and response sharing the common M. There were three different S-R pair-mediator combinations. Seven *Ss* had combination 1, seven had combination 2 and six had combination 3 in each group. The different combinations are shown in Table 1.

TABLE 1

PAIR-MEDIATOR COMBINATIONS

| Mediator | Combination 1 | | Combination 2 | | Combination 3 | |
|---|---|---|---|---|---|---|
| | S | R | S | R | S | R |
| ss | VOM | DAP | CAK | HEG | BUV | MEF |
| ms | ROX | PID | KIV | YAG | TOZ | QAD |
| ws | JAD | WIB | GAW | LIR | ZAM | FON |
| st | TOZ | QAD | ROX | PID | KIV | YAG |
| mt | BUV | MEF | JAD | WIB | CAK | HEG |
| wt | ZAM | FON | VOM | DAP | GAW | LIR |
| oo | GAW | LIR | BUV | MEF | ROX | PID |
| oo | CAK | HEG | TOZ | QAD | VOM | DAP |
| oo | KIV | YAG | ZAM | FON | JAD | WIB |

In Phase I *Ss* received the stimulus CVC in either a forward or backward sequence. In the forward sequence *Ss* were instructed to pronounce the CVC as soon as it was presented. The syllable was on the screen for 2 sec., immediately after which the appropriate shock or tone M was presented for 2 sec. Nothing was presented following the oo control syllables. The $M_n$ — $CVC_{n+1}$ interval was 5 sec. Each set of the nine CVCs was presented 8 times in different random orders.

In the backward sequence *Ss* were also instructed to pronounce the CVC as soon as it was presented. It remained on the screen for 2 sec. Two sec. before

the syllable was presented, the appropriate mediator (shock or tone) was presented and was terminated by *E* as soon as *S* pronounced the syllable. Nothing was presented prior to the oo control syllables. The $CVC_n$ — $M_{n+1}$ interval was 5 sec. Each set of nine CVCs was presented 8 times in different random orders.

In Phase II *S*s received the response CVCs in either the forward or backward sequence as described above. Immediately after Phase I and after Phase II *S*s were requested to write down the syllables they could recall in 2 min. The recall requirement was included in the instructions prior to each phase.

In Phase III all *S*s received the same standard paired-associate learning. The stimulus (Phase I) CVC and response (Phase II) CVC which were associated with the same mediator were paired in Phase III. The stimulus was presented for 2 sec., and 3 sec. later the S-R pair was presented for 2 sec. and the pair $_n$ — $S_{n+1}$ interval was 3 sec. The list was presented in four different random orders for 13 trials.

The four groups were distinguished by the sequence they received in Phases I and II: Forward Chaining (FC), Backward Chaining (BC), Response Equivalence (RE), and Stimulus Equivalence (SE). The conditions of each group are reviewed in Table 2.

TABLE 2

SEQUENCES FOR EXPERIMENTAL GROUPS

| Group | Phase I S Familiarization | Phase II R Familiarization | Phase III Paired-associate |
|---|---|---|---|
| FC | $CVC_S$-M | M-$CVC_R$ | $CVC_S$-$CVC_R$ |
| SE | $CVC_S$-M | $CVC_R$-M | $CVC_S$-$CVC_R$ |
| BC | M-$CVC_S$ | $CVC_R$-M | $CVC_S$-$CVC_R$ |
| RE | M-$CVC_S$ | M-$CVC_R$ | $CVC_S$-$CVC_R$ |

*Apparatus*

The experiment was conducted in a darkened room. The syllables were projected by a Kodak Carousel projector onto the back of a 12-in. by 18-in. piece of milkglass. The glass was mounted at eye level in a large black wooden screen which separated *S* from *E* and the apparatus. The syllables were white on black, 2 in. high and approximately 2 ft. from the seated *S*. All temporal intervals were controlled by Hunter Decade Interval Timers. The selection of mediators and duration of mediators in the backward sequence were controlled by *E* using a pushbutton control box.

Shock was presented through a cuff worn on the left forearm of *S*. The shock source was a Hunter Model 350 Shock Stimulator (Series D) which delivered shocks of 90 v (strong), 60 v (medium) or 45 v (weak) regulated by resistors in series with *S*.

The auditory mediators were 1,000-cps tones generated by a Hewlett Pack-

ard audio-frequency generator, amplified and modified by series resistors for three levels of loudness: 105 db, 87 db, and 64 db, and presented to *S* through a 12-in. speaker located on *S*'s immediate right.

## RESULTS

The first trial on which each response term was correctly anticipated in Phase III was recorded for each S-R pair. Any response that was not correctly anticipated by the 13th trial was arbitrarily given a score of 14 since the study was terminated at that point. Of a possible total of 720 such scores (9 item pairs, 80 *S*s) only 29 were assigned scores of 14. Of these 29, the range among *S*s was from 0 to 2, and they were equally distributed among paradigms. The scores from the three non-mediated pairs (oo) were averaged to obtain a mean control-pair comparison for the six mediated pairs. Difference scores were computed by subtracting the non-mediated pair score of each *S* from his score on each of the other pairs.

An analysis of variance was performed on these data with mediation paradigm (P) as between-subject effects and type of mediator (T), intensity of mediator (I), and the I $\times$ T, P $\times$ T, P $\times$ I and P $\times$ T $\times$ I interactions as within-subject effects. Only intensity of mediator ($F = 4.68$, $df = 2/380$) reached the .05 level of significance.

Trials to criterion for each type of mediator are shown in Table 3. A Tukey Multiple-comparison test was applied to this data. The error term (3.20, $df = 228$) was the mean square error within-*S*s calculated from an analysis of variance using the original data with paradigms (P) as the between-subjects effect and Levels (L) (strong (sg), medium (md), weak (wk), non-mediated (oo)) and the L $\times$ P interaction as within-subjects effects. Only levels ($F = 8.66$, $df = 3/288$, $P < .001$) was significant. The Tukey test showed only the md-wk difference failed to reach the .05 level of significance.

A criterion of trials to two successive correct responses for each item was subjected to the same analysis and yielded comparable results.

An analysis of item difficulty, independent of mediator, showed no significant differences, nor were there any differences between control pairs.

TABLE 3

TRIALS TO FIRST CORRECT RESPONSE PARADIGM

| Mediator | ABC | AAC | BAC | BBC | *M* | Intensity |
|---|---|---|---|---|---|---|
| ss | 3.10 | 4.05 | 4.25 | 3.95 | 3.95 | sg |
| st | 4.85 | 4.15 | 4.25 | 3.00 | | |
| ms | 4.20 | 4.30 | 4.35 | 4.50 | 4.58 | md |
| mt | 4.65 | 5.00 | 5.15 | 4.50 | | |
| ws | 5.10 | 4.00 | 5.60 | 4.75 | 4.78 | wk |
| wt | 4.95 | 4.25 | 5.05 | 4.55 | | |
| oo | 5.57 | 5.17 | 5.32 | 5.45 | 5.38 | oo |

The data from free recall at the end of Phases I and II showed no significant differences, either between paradigms, between types of mediator, or among levels of intensity.

## Discussion

The significant main effect from level of mediator supports the hypothesis that non-verbal stimuli serve effectively to facilitate paired-associated learning. Analytically, it further indicates that intensity facilitated the Phase III learning in this experiment. The Tukey analysis shows that the amount of facilitation was directly related to the degree of intensity (see Table 3).

Another comparison which reflects the function of the non-verbal material is the relative amount of overt errors made during Phase III learning. Table 4 presents the number of overt errors for each mediator pair. In each case the errors are greater for the adjacent intensity within modality. This generalized responding, along the intensity dimension within modality, is further evidence that these non-verbal stimuli are playing a functional role in paired-associate learning.

TABLE 4

Generalized Overt Errors

| Stimulus | ss | ms | ws | st | mt | wt |
|---|---|---|---|---|---|---|
| ss | | 19 | 5 | 6 | 12 | 12 |
| ms | 21 | | 4 | 9 | 10 | 3 |
| ws | 16 | 21 | | 10 | 9 | 7 |
| st | 11 | 13 | 12 | | 16 | 4 |
| mt | 11 | 16 | 5 | 18 | | 10 |
| wt | 8 | 11 | 10 | 9 | 17 | |

The question remains as to whether verbal and non-verbal mediation are comparable processes. Since the present study was modeled after standard verbal mediation paradigms, procedural factors are analogous. With respect to the results, the failure in this study to find paradigm differences is paralleled by the results of Horton and Kjeldergaard (1961) using verbal mediators.

One possible difference between the use of verbal and non-verbal mediational materials may be the hypothesized process involved. Schulz and Lovelace (1964) interpret verbal mediational facilitation to be an active process, conceivably a function of *S*'s actually making a "mediating response." With non-verbal mediators, it is difficult to conceive of *S* making a "tone mediator" or "shock mediator" response. If only shock mediation was a significant effect, a mediating "fear response" or "emotional response" could be proposed as the active mediational component. However, since both shock and tone appeared to be equally effective, a simple fear-mediation interpretation cannot be applied. It is interesting to note, however, that the direction of generalized overt errors indicates

that the greatest degree of response interference is a function of mediation similarity. It is possible that *Ss* were applying verbal labels to the shock and tone. However, if this were the case, it is not clear why facilitation should be a function of intensity. The critical test for this hypothesis would be pairs mediated by explicit verbal labels such as strong tone, medium tone, etc., where facilitation would be a function of the denotative "strength" of the mediator.

In summary, these results may be interpreted along several possible lines: mediation by an emotional response, facilitation as a function of the use of verbal labels, or simply mediation as a function of stimulus intensity. One or more of these hypotheses may be involved in the interpretation of this study, and it is not possible, at this point in the research on non-verbal materials, to be more than speculative. It is clear, however, that non-verbal mediation requires further investigation in terms of both the intensity and aversive qualities of the mediator and that this direction of research may help explain the mechanisms involved in the mediation process or processes.

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