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Ease of Verbal S-R Learning as a Function of the Number of Mediating Associations[1]

JOHN P. HOUSTON[2]

University of Michigan, Ann Arbor, Michigan

Investigations concerned with the determinants of mediated paired-associate (PA) learning have recently been on the upsurge (Jenkins, 1963). A potential addition to the list of significant parameters is the number of independent mediating units existing between the to-be-learned units. If the paired-associate stimulus (A) and the response (C) are independently connected to both B and D, then A-C learning may be accomplished more easily than if A and C are connected to a single mediating unit B. In other words, the A-B-C and the A-D-C chains should contribute more to A-C facilitation than the single A-B-C chain. Similarly, the existence of a single mediator (B) will lead, as many studies indicate, to greater ease of A-C learning than will no mediator at all. In general, as the number of mediating connections increases, A-C facilitation should increase; the probability of mediated activity is enhanced as the number of independent chains increases. This proposal is not merely a logically possible one; it finds some support in the recent work on associative overlap (Deese, 1962; Garskof and Houston, 1963). These authors have described the strength of relationship between two verbal units in terms of the number of common word-association responses. Each common word associate may be thought of as a mediating chain betwen the two stimulus words.

The present study was designed to test the hypothesis that ease of PA learning is a function of the number of existing mediating units by comparing A-C learning under three mediating conditions. Paired-associate learning, generally conforming to the A-B, C-B, A-C paradigm, was used to establish either 0, 1, or 2 mediating chains.

METHOD

Subjects. The *Ss* were 64 Michigan undergraduates whose participation was in fulfillment of a course requirement.

Design. The design of the experiment is shown in Table 1. Prior to A-C learning *Ss* learned either two or four six-item PA lists. A single mediator (B) was established through A-B, C-B learning in condition E1, while a second mediator (D) was associated with A and C in condition E2 through the additional A-D and C-D learning. C1 and C2 were nonmediational control conditions against which the effects of E1 and E2 could be judged. The hypotheses were, specifically, (a) that ease of A-C learning in the E1 condition would be greater than in the C1 condition, (b) that ease of A-C learning would be greater in E2 than in C2, and (c) that the degree of facilitation in the E2 condition would be greater than in E1. The increase in the number of mediators should raise the over-all probability of mediational activity.

Lists. Two sets of six two-digit numbers (10, 11, 12, 13, 14, 15; and 16, 17, 18, 19, 20, 21) were employed as C and Y units. Two sets of six single letters (A, B, C, D, E, F; and G, H, I, J, K, L) were used as A and X units. The use of these highly familiar sequences presumably reduced differences between the experimental and control conditions with regard to stimulus predifferentiation and response integration. Control *Ss* were informed, prior to A-C

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[2] Now at the Institute of Human Learning, University of California, Berkeley

TABLE 1
DESIGN OF THE EXPERIMENT

	Condition 1		Condition 2	
Stage	Experimental (E1)	Control (C1)	Experimental (E2)	Control (C2)
1	A-B	X-B	A-B	X-B
2	C-B	Y-B	C-B	Y-B
3			A-D	X-D
4			C-D	Y-D
Test-stage	A-C	A-C	A-C	A-C

TABLE 2
MEAN VALUES OF DEPENDENT VARIABLES FOR THE FOUR CONDITIONS

	Mean				
	C1	C2	C1C2	E1	E2
No. correct on Trial 1	0.875	0.813	0.844	1.750	2.437
No. correct on Trials 2 and 3	2.313	2.500	2.406	4.063	6.063
No. trials to criterion	8.687	8.187	8.438	6.813	5.438

learning, of the range of elements to be employed in A-C learning.

Two sets of six nonsense syllables served as mediating elements (B and D). One set included ZUT, MEC, YOM, PAF, RIX, and NAX, while the other was composed of SEB, WEZ, TUV, XOJ, VIB, ZAT. It should be noted that none of these began with the letters A through L. The Glaze (1928) association value of each syllable was either 13 or 7%. The mean of each set of association values was 11%.

The two sets of letters were assigned equally frequently to the *Ss* in each condition. Similarly, the two sets of numbers were assigned to half the *Ss* in each condition. The two nonsense-syllable sets were paired equally frequently with the two sets of numbers and the two sets of letters in each condition. The two groups of syllables appeared equally frequently as B and D items. Two random pairings of the stimuli and responses in each PA list were developed. Finally, the six pairs in each list were placed in three random orders to minimize serial learning.

Procedure. The four conditions were randomized 16 times such that each condition occurred once in each of 16 blocks. The 64 *Ss* were assigned to these blocks in the order of their appearance in the laboratory for a total of 16 *Ss* per condition. Following the usual PA instructions, Stage-1 learning was carried to a criterion of one perfect trial on a Stowe memory drum at a 2:2-sec rate, with a 4-sec intertrial interval. The same procedure was followed for both experimental and control groups until the learning stages were completed (either two or four lists). Forty-five sec separated the learning of all lists. Immediately following the final learning stage, *E* informed *S* that the next list would be composed of the letters and two-digit numbers. The *S* was instructed to guess which number was paired with which letter on the first run through the list. Test-Stage learning was carried to one perfect trial.

RESULTS

The mean numbers of trials to a criterion of one perfect trial on the first list were 16.06, 16.00, 15.96, and 15.35 for the E2, E1, C1, and C2 conditions, respectively. These means did not differ significantly, ($F < 1.00$), indicating that the groups were of comparable learning ability.

Table 2 shows the mean values for each of three dependent variables, viz., number correct on the first Test-Stage presentation of the stimuli before the responses were exposed, number correct on the second and third Test-Stage trials, and number of trials to criterion. The differences between the C1 and C2 means for each of the three measures were not significant (t's < 1.00), justifying the combination of the two control groups into a single group against which the effects of E1 and E2 could be judged. The means of the combined C1 and C2 groups are contained in Table 2.

The differences between the three means (E1, E2, C1C2) for each measure were evaluated by means of simple random-design analyses of variance. The F for the Number Correct on Trial 1 was 13.90 ($df = 2/61$, $p < 0.01$). For the Number Correct on Trials 2 and 3 the value of F was 10.92 ($df = 2/61$, $p < 0.01$), while the F for the Number of Trials to Criterion was 9.28 ($df = 2/61$, $p < 0.05$). The Scheffé test (Winer, 1962) was employed to locate significant differences within each set of three means. All paired comparisons of the means of Number Correct on Trial 1 were significant at the 0.01 level, with the exception of the E1-E2 difference, which was significant at the 0.05 level. All comparisons of the means of Number Correct on Trials 2 and 3 were significant at the 0.01 level. The only significant difference found within the means of Number of Trials to Criterion was between the C1C2 and the E2 conditions ($p < 0.05$).

There were no significant differences between the experimental and control conditions in the number of units from the correct set given on the first Test-Stage trial (whether right or wrong). Conditions E1 and E2 combined gave 169, while C1 and C2 combined produced 170 correct-set responses. There were no differences in the number of intrusions produced by the experimental and control conditions on the first Test-Stage trial (2 and 3 intrusions, respectively). Thus it may be concluded that the reported differences were not the result of differences between the experimental and control conditions with respect to stimulus and response availability because, if they had been, one would have expected more correct-set responses and fewer intrusions in the experimental groups.

Discussion

The principal finding of the study was that ease of PA learning is a function of the number of mediating associations existing between the stimulus and response units. Paired-associate learning in the condition involving two mediating chains was significantly better than learning involving one mediating chain. The single mediator produced greater ease of learning than the nonmediated condition. These results clearly indicate that number of mediating associations should be added to the already considerable list of empirically demonstrated parameters of mediated PA learning (i.e., length, strength, quality, and direction of mediating chains).

These findings suggest that, under certain circumstances, the functional stimulus in PA learning (Underwood, 1963) may not be the same as the nominal one or some component of the nominal stimulus, but may involve additional material associated with, and elicited by, the nominal stimulus. Similarly, the functional response, or the response employed by *S*, may be something more than the nominal response or the response manipulated by *E*. Whether *S* will select a component of the nominal learning unit or employ additional material evoked by the nominal unit may well be dictated by the "law of least effort." The greater the number of common associations attached to the stimulus and response the more *S* will benefit from them in establishing an S-R connection, and, therefore, the more likely he is to attend to them rather than to the nominal response or to some selected portion of the nominal stimulus. This is not incompatible with Underwood's (1963) statement that selection and employment of some aspect of the nominal stimulus decreases as the meaningfulness of the nominal stimulus increases. If it is assumed that highly meaningful units have a greater number of associates and that the probability of common associates is greater for high than for low meaningfulness, then attention to the nominal stimulus and its associates should be greater with high than with low meaningful units.

It is of interest to note that the measure reflecting the entire course of learning (Number of Trials to Criterion) provided a weaker demonstration of the mediation effect than did either of the measures reflecting the early

phases of learning (Number of Correct Responses on Trial 1, and on Trials 2 and 3). This could indicate that mediation effects will appear most strongly early in learning because, as learning progresses, the mediating connections are unlearned. In other words, in an A-B, C-B, A-C paradigm, A-C learning may be associated with the unlearning of the A-B associations. The arousal of the mediator (B) is reduced as the unlearning of A-B continues, resulting in a reduced mediation effect as A-C learning progresses.

Summary

It was hypothesized that ease of verbal S-R learning is a function of the number of mediating units existing between the S and the R. Prior to the test stage three groups of *Ss* associated either 0, 1, or 2 nonsense syllables with both two-digit numbers and single letters. During the test stage the ease with which the three groups learned pairs composed of the letters paired with the numbers was measured in terms of three dependent variables. The results indicated significant differences among the three mediating conditions, with the two-mediator condition showing the most, and the nonmediated condition the least, test-stage facilitation.

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