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Simulation with EPAM of Verbal Learning Experiments Involving Varying Amounts of Intra-List and Inter-List Similarity

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In the experimental literature on verbal learning, one of the variables that has been studied frequently is the amount of intra-list or inter-list similarity among the items on the lists to be learned. In an experiment on the learning of nonsense syllables by the paired-associate method, Underwood, for example, considered five conditions of intra-list similarity: (1) low intra-list similarity for both stimulus and response syllables, (2) medium similarity for stimulus syllables, low similarity for response syllables, (3) high similarity for stimulus syllables, low similarity for response syllables, (4) low similarity for stimulus syllables, medium similarity for response syllables, (5) low similarity for stimulus syllables, high similarity for response syllables. Similarity was increased by constraining the alphabet of letters from which the syllables were constructed.

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Similarly, Bruce studied the effects of inter-list similarity by having subjects learn two paired-associate tasks in succession, with varying similarity between syllables in the first and second tasks. If S1, R1, S2, and R2 designate the sets of stimuli and responses for the first and second tasks, respectively, then Bruce's three experimental conditions may be described as: (1) S2 distinct from S1 and R2 distinct from R1; (2) R2 identical with R1, but S2 distinct from S1; (3) S2 identical with S1, but R2 distinct from R1.

Intra-list Similarity. Underwood took as his performance measure the average number of trials required to learn the set of paired associates to criterion (one successful performance). In the simulation we take number of errors as the performance measure. In Table I, we compare the data presented by Underwood with the results obtained with EPAM when it was given the task of learning the same syllable pairs used by Underwood.

TABLE I

List	Underwood	EPAM III	EPAM III-3
LS-LR	94	107	94
MS-LR	103	102	124
HS-LR	123	98	131
LS-MR	90	100	92
LS-HR	98	93	98

In Underwood's experiment, amount of response similarity appeared to have little effect upon learning--the set with low response similarity was learned more slowly than the set with medium response similarity but more quickly than the set with high response similarity. In the simulation, rate of learning varied directly with amount of response similarity.

In Underwood's experiment, rate of learning varied inversely with amount of stimulus similarity; in the simulation, rate of learning varied directly with amount of stimulus similarity. However, in the simulation, amount of stimulus similarity had a smaller effect upon learning rate than did amount of response similarity.

We see that both with the human subjects and the simulation, manipulation of intra-list similarity affected learning. The effects were very different in the two cases, however. With the human subjects stimulus similarity (but not response similarity) impeded learning; with EPAM, similarity, and especially response similarity, facilitated learning. The only resemblance--albeit an important one--between the two sets of data was that response similarity had a relatively more favorable (or less unfavorable) effect on learning in both cases than stimulus similarity.

Examination of the way in which similarity might be expected to affect the mechanisms incorporated in the EPAM program casts some light on these results. There are two leaning mechanisms: one elaborates the discrimination net, the other elaborates the stimulus and cue images stored in the net. The stimulus image is elaborated only to the extent needed to discriminate among stimuli; the response image must be complete in order to enable a response to be made. In EPAM, any condition that causes more complete information to be stored for purposes of discrimination evidently speeds the completion of the response images. But the higher the similarity among stimuli--and especially among responses, the more complete will have to be the images for purposes of learning to discriminate. Hence, high similarity facilitates response learning. That the facilitation will be greatest for high response similarity is clear.

Because failure to discriminate in EPAM causes feedback that automatically improves the discrimination net and images, high similarity did not noticeably slow down discrimination learning in the simulation. To explain the decrement in discrimination in the human subjects, we must postulate that their discrimination learning processes involve less direct feedback from the experienced confusion among the stimuli or responses--that the greater similarity among the stimuli does not increase the rate at which the discrimination net is elaborated.

<u>Inter-list Similarity</u>. In Table II, we compare the data of Bruce with the results obtained with EPAM using the same experimental design.

TABLE II

Condition	Bruce	EPAM II	EPAM III (2)	EPAM III (3)
Distinct Lists	84	111	47	84
Identical Responses	63	61	32	49
Identical Stimuli	109	99	37	91

Again, in Bruce's experiment with human subjects, response similarity facilitates, and stimulus similarity impedes learning. In the simulation, both response and stimulus similarity facilitate learning, but response similarity produces the greater facilitation. The facilitation resulting from identical stimuli in EPAM can be explained by the fact that under this condition a smaller total number of syllables must be discriminated than in the condition where both stimuli and responses are different in the two sets of syllable pairs. In EPAM, however, getting rid of the incorrect responses (from the initial task) does not impede associating new responses with the same stimuli.

If we compare the kinds of errors made by EPAM in learning the second set of syllables under the second and third experimental conditions we find that, when responses were identical, but stimuli different, 28 or 48 errors were "no response," the others were incorrect responses; when the stimuli were identical but the responses different, only 4 of 42 errors were "no response." Under the former condition, most of the incorrect responses were made on the third through the fifth trials; under the latter condition, on the first through fourth trials.

Conclusion. In the experiments presented here, we have succeeded in reproducing with EPAM the experimental conditions studied by Underwood and Bruce. We have not succeeded in reproducing very well the results they obtained from human subjects.

By pinpointing, however, the differences between the human and the simulated performance, we obtain important diagnostic information to help us locate the site of the discrepancy and to modify EPAM in order to remove it.