Children's recall of S+, S−, and S^0 as a function of feedback frequency

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Children were given the minimum number of trials necessary to provide explicit information about both S+ and S− in a series of discrimination learning problems. In addition, a third stimulus (S^0) was present but never responded to by the Ss. Comparisons of S+ and S− recall with recall of S^0 indicate that discrimination training facilitated S+ memory but did not affect S− memory. The superiority of S+ recall was not the result of a greater number of S+ trials, as might have been the case in previous studies, nor an artifact of recency, also possible in previous studies. The possibility of two independent effects of discrimination training on memory was considered, one concerned with the consequences associated with each stimulus and the other concerned with the strength of memory. Finally, the pattern of results was stable over the course of three consecutive discrimination problems.

Recent research in discrimination learning has emphasized the question of what operations during training affect subsequent recall of positive (S+) and negative (S−) discriminative stimuli. One consistent finding is that recall of S+ is better than recall of S− when Ss do not verbalize S− during training. This difference is found in both school-aged children (Deichmann, Speltz, & Kausler, 1971; Goulet & Hoyer, 1969) and college-aged Ss (Carmean & Weir, 1967; Goulet & Hoyer, 1969; Kausler & Sardello, 1967; Rowe & Paivio, 1971; Weir & Helgoe, 1968).

Despite repeated replications, however, little more is known about the superiority of S+ recall beyond the fact that it occurs consistently. One of the most critical empirical gaps is concerned with whether discrimination training, such as is used in the cited studies, serves to facilitate or to inhibit recall of a stimulus relative to nondiscrimination training (i.e., training in which no feedback is given to indicate that the stimulus is "correct" or "incorrect"). Also undetermined is whether feedback about S+ or feedback about S−, or both, is responsible for the differential recall of S+ and S−. In all of the cited studies, several patterns of facilitation and inhibition due to discrimination training are possible: (1) recall of S+ is facilitated by the informative feedback, while recall of S− is inhibited; (2) recall of both are facilitated, but S+ to a greater degree; (3) recall of S+ is facilitated, but recall of S− is unaffected; (4) recall of S− is inhibited, but recall of S+ is unaffected; (5) recall of both are inhibited, but S− to a greater degree. In short, we know that differential feedback about two stimuli (i.e., discrimination training) produces a relative difference in recall of those stimuli, but we do not know the directions of change, nor do we know which type of feedback is responsible for the difference.

These questions can be answered by comparing the effects of S+ and S− feedback with that of a no-feedback condition. (A stimulus used in a no-feedback condition is labeled here a "neutral stimulus," or S^0, and is defined as a stimulus that has the same a priori probability of being observed by S as have S+ and S− but has never been responded to in a manner that would provide feedback as to whether it is a positive or negative stimulus.) One purpose of this study, then, is to provide data comparing children's recall of S+ and S− with recall of S^0 in order to determine the pattern of facilitatory and inhibitory effects of S+ and S− feedback on memory.

Not controlled in any of the cited studies is the exact number of times S+ and S− feedback are given. The difference in S+ and S− recall that is typically obtained might be due simply to more frequent S+ feedback rather than to a difference in the effectiveness of S+ and S− feedback. Deichmann et al and Goulet and Hoyer partially controlled for this variable by manipulating the number of consecutive choices of S+ prior to recall. However, the total number of choices of S+, as well as the number of S− choices, was uncontrolled. In order to adequately determine the relative effectiveness of S+ and S− feedback in modifying recall, the frequency of both must be controlled. A second purpose of this study is, therefore, to provide data comparing children's recall of S+ and S− after an equal number of S+ and S− feedback trials, as well as after more frequent feedback about S+ than about S−.

Yet another aspect of this study not investigated in previous studies is concerned with the effect of minimal feedback. Deichmann et al and Goulet and Hoyer presented at least two S+ feedback trials with an unspecified number of S− feedback trials. Kausler & Sardello (1967) presented at least five feedback trials for which the number of neither S+ nor S− feedback trials was specified. In order to provide explicit information about both S+ and S−, only two feedback trials are needed, one for S+ feedback and one for S−. The present study asks, therefore, whether children will show differential recall of S+ and S− after only one feedback trial about each.

Finally, this study is concerned with the stability of feedback effects on recall over several problems. Thus, S+, S−, and S^0 recall were sampled after each of three problems for each S.

SUBJECTS

Twelve second-grade and eight third-grade children were drawn from a local elementary school and assigned randomly to two experimental groups without regard for sex or grade level. Two Ss from one group were subsequently dropped from the experiment for reasons described in the procedure section.

APPARATUS

The experiment was conducted in a quiet corner of the school library. Ss faced a cardboard partition in which three 3-5/8-in.-square windows were cut. The three windows were arranged asymmetrically such that they were aligned neither horizontally nor vertically. The left window was positioned nearest the top of the partition, the middle window nearest the bottom, and the right window midway between the top and bottom. A second partition without windows could be raised and lowered in front of the display partition.

Stimuli were consonant trigrams constructed from 48-point press-on type. Three sets of three trigrams each were constructed with the conditions that no consonant could appear more than once in each set of trigrams nor more than twice in all three sets. The average association value of the trigrams was computed from Appendix F of Underwood & Schulz (1960), the "letter-sequence habit" norms. The mean tabled values (converted to percentages) were 1.1% for responding with the second letter in each trigram given the first letter and 3.8% for the third letter given the first two. These values indicate trigrams of low association value.

PROCEDURE

The Ss were brought individually to the library and told that they were going to play a game. They were told that they were to see some windows with letters in them and that they were to point to the "good" letters. In

Table 1
Mean and Standard Deviation (SD) of the Number of S+, S−, and S^0 Letters Recalled for Each Criterion Condition and Each Problem

	Stimuli					
	S+		S−		S^0	
Conditions	Mean	SD	Mean	SD	Mean	SD
1 S+	1.8	0.8	1.1	1.1	0.9	0.9
3 S+	1.7	0.9	0.9	0.9	1.2	1.0
Problems						
1	1.5	0.9	1.2	1.1	1.0	0.9
2	2.2	0.9	0.7	0.8	0.9	1.1
3	1.6	1.0	1.2	1.1	1.2	0.8

three instances, the additional instruction "all the good letters are in the same window" was given when an S began naming letters in different windows.

The order in which the three sets of stimuli were used was determined randomly for each S, as was the assignment of stimuli to windows (position of the stimuli did not change from trial to trial). The first set of stimuli (Problem 1) was presented in the three windows by raising the blank partition until S pointed to one of the three trigrams, at which time the partition was lowered and E provided verbal feedback. Each S was told, "No, that's not the good one," on the first trial regardless of which stimulus he pointed to. Thus, the first stimulus chosen by each S was designated S− for that S. On the second trial, all Ss were told, "Yes, that's the good one," regardless of which of the two previously unchosen stimuli was now chosen. This stimulus was designated S+, and the remaining unchosen stimulus was designated S^0. For one group (1S+), training was terminated at this point and S was asked to write down all the letters he could recall. Then the second set of stimuli was presented, using the same training and recall procedure (Problem 2), followed in turn by the final set (Problem 3). After recall of the final set, S was assured that he had played the game successfully and was escorted back to his home room. The other group (3S+) was treated in the same manner, except that for each problem three consecutive choices of S+ were required before a recall test was given. Any S that chose S− after Trial 1 or S^0 after Trial 2 was dropped from the experiment.

The experimental design consisted of three factors: criterion (one or three choices of S+), problem (first, second, or third set of trigrams), and stimulus (recall of letters from the S+, S−, or S^0 trigram). The problem and stimulus factors were within-Ss variables and the criterion factor was between-Ss.

RESULTS

The difficulty of the discrimination task was such that S− was seldom chosen after the first trial. Out of a total of 120 trials in the experiment, only two such deviations occurred, both from Group 3S+. Both of these Ss were dropped from the experiment, necessitating the use of an analysis of variance on unequal Ns. The method of unweighted means, described in Winer (1962), was used.

The mean and standard deviation of the number of S+, S−, and S^0 letters recalled from each problem and after each criterion is shown in Table 1. These scores can be compared to a maximum possible mean score of 3.0 in each cell and expected standard deviation of approximately 1.1. An analysis of variance (Criterion by Problem by Stimulus by S) performed on these data revealed a significant main effect for the stimulus factor ($F = 6.14$, $df = 2/32$, $p < .01$). No other main effect or interaction approached significance at the .05 level. A Newman-Keuls test for differences between pairs based on the significant main effect of the stimulus factor indicated that S+ letters were recalled better than either S− or S^0 letters ($p < .01$ in each case) but that recall of S− and S^0 letters did not differ.

DISCUSSION

The finding that S+ recall exceeded S− recall is consistent with the findings of previous studies that tested children with no verbalization requirement (Deichmann et al, 1971; Goulet & Hoyer, 1969). Of the five patterns of facilitatory and inhibitory effects of S+ and S− feedback on S+ and S− recall that are possible in those studies, one is strongly supported by the present comparisons of S+ and S− recall with recall of the neutral stimulus S^0: recall of S+ was facilitated, but recall of S− was unaffected. While the facilitation of S+ recall is not surprising, the fact that S− recall was unaffected suggests some intriguing speculation. Two relatively independent effects of discrimination training are suggested: enhancing the code of a stimulus already in memory (i.e., strengthening memory), and recoding that stimulus to indicate its associated consequences. In the present study, these effects would be reflected in the facts that Ss seldom chose S− after S− feedback (i.e., it had been recoded "avoid") but yet recalled it no better than a neutral stimulus (i.e., its status in memory had *not* been enhanced). On the other hand, Ss consistently chose S+ after S+ feedback, indicating that it had been recoded "approach," and also recalled it better than S^0, indicating that its status in memory had been enhanced.

The superiority of S+ recall was evident in the present study following the minimum number of trials necessary for providing explicit information about both S+ and S−. Further, S+ superiority was evident after an equal number of S+ and S− feedback trials. Thus, the S+ superiority found in previous studies (Deichmann et al, 1971; Goulet & Hoyer, 1969) need not be the result of providing a greater number of S+ feedback trials. It might still be argued that the superiority of S+ recall in this and previous studies is simply an artifact of recency, since in each study recall was tested only after a number of consecutive S+ trials. Counter to this argument, however, is the fact that in the present study S− recall was no weaker relative to S+ recall following three consecutive S+ trials than it was following one such trial. That is, whether the last S− feedback occurred one or three trials prior to the recall task did not affect the superiority of S+ recall. Superior S+ recall in children need not, therefore, be an artifact of recency.

Finally, it was found that the facilitatory effects of S+ feedback were stable over the course of three consecutive problems. Total items recalled did not change, nor did the relationships between S+, S−, and S^0 recall.

In sum, children recalled S+ better than S− even after a minimum number of trials, at least when the consequences associated with S− were minimal. The effect is not the result of providing more S+ feedback trials, nor is it necessarily an artifact of recency. Finally, discrimination training might serve two independent functions: to recode the stimuli in keeping with their associated consequences, and, under certain conditions, to enhance their representation in memory.

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