Response mode as a determinant of transfer from serial to paired-associate learning¹

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The study investigated the effects of vocal and nonvocal responding to the stimulus terms in a PA task derived from a previously learned serial list. Seventy-two Ss learned lists of pronounceable trigrams under four transfer and two control conditions. Performance on a single-function, derived PA list was facilitated when stimulus terms were vocalized and inhibited when they were not, as compared with performance on a nonderived PA list. These results were discussed in terms of the nature of the effective stimulus in serial learning.

In the past few years a number of studies have attempted to clarify the nature of the so-called *effective* or *functional* stimulus in serial learning. The problem is that the traditional explanations of serial learning (sequential, position, and dual-process hypotheses) seem unable to account adequately for some serial phenomena (Jensen & Rohwer, 1965). All of these hypotheses, in their sundry forms, predict positive transfer in learning a paired-associate (PA) list which is appropriately derived from a previously learned serial list, i.e., derived in such a way as to maximize associational and/or positional cues. However, a frequent result of such transfer experiments has been either negative or no transfer (e.g., Young, 1962; Jensen & Rohwer, 1965; Martin & Greene, 1966), although, under relatively limited conditions positive transfer has been demonstrated (e.g., Crowder, Chisholm, & Fell, 1966; Postman & Stark, 1967).

Two explanations for the lack of positive transfer were suggested by Jensen & Rohwer (1965). First, one or more of the traditional hypotheses is correct but massive interference builds up from some sort of interaction between conditions of the two tasks. The second alternative is that serial learning takes place by some process which is essentially different from the process by which PA learning takes place. The purpose of the present paper is to show that the first alternative is more tenable, provided that the effective stimuli are adequately specified and utilized. The effective stimuli are not only the preceding items, as they appear on the serial list in the window of the memory drum, but also the individual's responses to these items as well as the auditory feedback which results from the responses. The importance of these factors has been

documented in stimulus familiarization studies (Gannon & Noble, 1961; Schulz & Tucker, 1962; Salafia, 1967). There is no reason to suspect that such factors as the S's responses and feedback are any less crucial in the serial-to-PA transfer situation than they are in stimulus familiarization. Thus, the present study manipulated the presence or absence of these two factors by controlling the manner in which Ss responded to stimulus items in a PA task after serial learning.

DESIGN

Six experimental conditions were established with 12 Ss per condition, all of whom learned the same set of trigrams in the PA task. Differences among the six conditions were in terms of (1) type of response (vocal or nonvocal) to the stimulus term in the PA task, (2) presence or absence of a prior serial task, and (3) if present, the relevance of the serial list to the PA list.

Two groups learned a relevant serial list, then a PA list composed of alternate pairs of items from the serial list (single function, derived PA list). The difference between these two groups was in responding vocally or nonvocally to the stimulus items in the PA task. Two control groups learned an irrelevant serial list, then the same PA list as above. Again, the only difference between these two groups was in the manner of responding to the stimulus terms in the PA task. Two other groups learned only the PA list, without prior serial learning. The six experimental conditions may be summarized as follows: Positive Transfer Group (Pos T): Learn relevant serial list; learn derived PA list, stimulus words vocalized. Positive Transfer Control Group (Pos TC): Learn irrelevant serial list; learn nonderived PA list, stimulus words vocalized. No Transfer Group No. 1 (NT1): No serial task; learn PA list, stimulus words vocalized. Negative Transfer Group (Neg T): Learn relevant serial list; learn derived PA list, stimulus words not vocalized. Negative Transfer Control Group (Neg TC): Learn irrelevant serial list; learn nonderived PA list, stimulus words not vocalized. No Transfer Group No. 2 (NT2): No serial task; learn PA list, stimulus words not vocalized.

MATERIALS

The learning materials were two sets of pronounceable trigrams, each set consisting of 12 items. One set was used in constructing the relevant serial list and the derived PA list, and the other was used as the irrelevant serial list. The sets were matched by frequency count on the basis of the table of trigram

frequencies in Underwood & Schulz (1960, pp. 332-369). Other than frequency count, the criteria for construction of the serial lists were that no initial letter be duplicated and the lists be physically and acoustically dissimilar. Five different orders of presentation of the six PA pairs were devised, in order to minimize positional cues and maximize associational cues in PA learning.

PROCEDURE

For both serial and PA lists, the items or pairs were presented on a Lafayette memory drum, at a 2-sec rate, with a 4-sec intertrial interval. The anticipation method was used with all items pronounced aloud, except for the three PA conditions in which the stimulus terms were not pronounced. The criterion for serial learning was one errorless run through the list, and for PA learning, two successive errorless runs through the list.

For the serial task, Ss were instructed to say the words aloud on the first run and then try to anticipate them on each successive run. After a 3-min rest during which PA instructions were presented, Ss were given the PA task and told to say (or look at) the stimulus terms and try to anticipate the response terms. In the two NT conditions, Ss were given only the PA task and instructions.

SUBJECTS

Seventy-two volunteer Ss (60 female, 12 male; mean age 32) all of whom were graduate students enrolled in the Fairfield University summer session, participated in the experiment. When it became obvious that more females than males would be available, the Ss were block randomized, so that 10 females and two males comprised the 12 Ss in each experimental condition. Five Ss were eliminated for failure to master the serial learning task. None were eliminated for failure to follow instructions, although the tendency to vocalize stimulus words in Neg T and Neg TC groups was evident.

RESULTS

Serial Learning

In addition to its function as part of the experimental design, performance on the serial task provided a rough measure of equivalence of lists and groups of Ss. As expected, there were no significant differences in either trials ($F < 1$) or errors ($F < 1$) among the four groups in which the serial learning task was present. These results suggest that differences in subsequent PA task performance were due to experimental

manipulation of response mode rather than to extraneous influences.

PA Learning

Figure 1 presents the mean number of trials and errors to criterion in PA learning for the six experimental conditions. The differences between data points in the figure fall into three rather clearly defined categories. First, the initial decline in both trials and errors to criterion from the NT conditions to the TC conditions indicates the presence of a nonspecific transfer (learning-to-learn) effect, since there was no serial learning task in the NT conditions and an irrelevant serial task in the TC conditions. Second, the separation between the curves at the NT to TC points is indicative of a difference attributable to the vocalization or nonvocalization of stimulus terms in the PA task, without regard to specific transfer from the prior serial task.

The third and, for the purposes of this study, most important bit of information in the figure is the difference between the T conditions. When Ss vocalized the stimulus terms in the PA task (Pos T), there was a further drop in the number of trials and errors to criterion, indicating a specific positive transfer effect due to the prior learning of the relevant serial list. However, when Ss did not vocalize the stimulus terms, there was a deficit in PA learning rate as indicated by an increase in the number of trials and errors to criterion. Analysis of variance revealed that the differences in performance among the four specific transfer conditions were statistically significant in terms of both trials to criterion ($F = 2.96$, $df = 3/44$, $p < .05$) and errors to criterion ($F = 4.03$, $df = 3/44$, $p < .025$).

In a further attempt to assess specific differences among data points the Mann-Whitney U test was used. This procedure was chosen because of the presence of extreme scores in some groups. Although such scores would not seriously reduce the sensitivity of the overall analysis, they would do so for parametric comparisons between specific data points. Comparison of the Pos T and Pos TC groups revealed that vocalization of stimulus terms led to a small and nonsignificant decrease in trials but a significant decrease in errors to criterion in the Pos T group ($U = 33.5$, $p < .025$). Comparison of the Pos T with Neg T groups revealed statistically reliable decrement in PA performance for the Neg T group in both trials ($U = 32.5$, $p < .025$) and errors ($U = 28$, $p < .01$). Although the amount of interference created by nonvocalization of stimulus items brought performance in the Neg T group to a level below that of the Neg TC group, differences between these two groups were not significant. It should be mentioned immediately, however, that there was no requirement that there be

Fig. 1. Mean number of trials and errors to criterion in the PA task as a function of transfer condition.

significant differences between these groups. It was expected that nonvocalization of the stimulus terms would lead to a significant decrement in performance with respect to the Pos T condition, which was shown. However, the amount of interference need not have been great enough to depress the level of learning in the Neg T group significantly below that of the Neg TC group.

DISCUSSION

Briefly, the findings of the present study were: (1) Learning of a PA list derived from a previously learned serial list was facilitated when stimulus terms were vocalized; (2) interference occurred in the learning of the same derived PA list when the stimulus members were not vocalized; and (3) the interference effect was sufficiently large to make performance of the Neg T group not only poorer than that of the Pos T group, but also poorer than that of the Neg TC group.

These results suggest that the interference found in this study, as well as others (Young, 1962; Jensen & Rohwer, 1965; Martin & Greene, 1966), may result from a simple and well known phenomenon in learning, namely, that old responses often interfere with the acquisition of new ones. More specifically, in the serial learning task, Ss have learned not only to *look at* the items but to *say and hear* each of the items in the list. In most previous transfer experiments, as well as in the Neg T condition of the present experiment, the PA task involved

merely looking at the stimulus word but not saying it aloud. Thus, the *saying and hearing* aspects of the stimuli were absent. These responses probably constitute a major part of what has come to be known as the effective stimulus used by Ss to cue anticipation of the next item in a serial list. When these cues are absent, as in the usual PA paradigm, the likelihood of anticipation of the response terms is lessened.

Furthermore, during serial learning, until each item is anticipated correctly, the usual procedure is to say each term as it appears in the memory drum. Thus the response to the appearance of a word in the memory drum is often to vocalize *that* word. Now, in the usual PA paradigm and in the Neg T condition of this experiment, the appearance of the word must elicit a new response, namely, vocalizing the response word. The response which had been learned in the serial task would ordinarily be expected to interfere with the learning of the new response term in the PA task.

In summary, the same factor may act in two ways to interfere with PA learning: (1) to change the effective stimulus from *seeing-saying-hearing* the stimulus terms to merely *seeing*, which should diminish positive transfer by the absence of previously available cues; and (2) to interfere with acquisition of the response called for in the PA task. In the Pos T condition of the present experiment, both of these interference effects were prevented from operating by virtue of the S's vocalizing the stimulus word in the PA task. Under these conditions, facilitation of PA learning occurred.

Several points should be made regarding the nature of the observed transfer effects. First, differences in both trials and errors between the NT groups and the TC groups were indicative of a nonspecific transfer or learning-to-learn effect. Moreover, differences in PA learning could be seen in both the TC and NT conditions, which differences were attributable to the nature of the response to the stimulus terms, without regard to specific transfer from the serial task. That is, the differences were not transfer effects, but rather they were differences in learning rate due solely to whether or not Ss vocalized the stimulus terms in the PA task. Thus, the design of the present study permitted relatively separate assessment of the magnitude of these nonspecific effects as well as specific transfer effects. Clearly, the remaining facilitation and interference observed in the Pos T and Neg T conditions, respectively, are attributable to the difference in response mode. The fact that such differences occurred over and above nonspecific effects, serves to reinforce the hypothesis that response mode is a crucial factor in the

determination of the direction and magnitude of transfer from a serial list to a derived PA list.

Another question that immediately arises is whether the effects noted in the present study were not simply due to procedural variations, and therefore of little theoretical relevance. Thus, an alternative interpretation of the data might suggest that negative transfer from serial to PA learning is the *usual* occurrence and positive transfer is merely an artifact of the *unusual* procedure of vocalizing the stimulus terms in the PA task. Although it is true that the procedures in the Pos T condition were different from those in the standard PA paradigm, such variations may be critical to an understanding of the serial learning process. If one wishes to obtain a relatively pure assessment of what is being transferred from serial learning (i.e., what is learned in serial learning), then it becomes necessary to alter the standard PA paradigm so that the rate of PA learning clearly reflects what was learned. Otherwise PA performance may be merely an artifact of interfering factors *built into* the standard PA paradigm, and not an adequate reflection of what was learned previously.

Although, by design, the sequential hypothesis was supported in the present experiment, the purpose of the study was not to contrast the traditional hypotheses, but rather to argue that one or more of them was sufficient to explain serial learning and that no new or different basic conception of the serial learning process was necessary. Under appropriate conditions, positional cues may also function in the serial learning process. However, it should be clear that sequential associations cannot be discounted as a major contributor to serial learning effects.

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- NOTE
1. This research was supported by NSF Institutional Grant GU-1203 to Fairfield University and was presented at the annual meeting of the Eastern Psychological Association, Washington, D.C., April 1968.
- FRANK D. MILLER, JANE DEE-WANG TU, GENE H. MOFFAT, and SHARON MANLEY, *University of South Dakota, Vermillion, S.D. 57069*
- On each of 81 trials, 4-, 7-, and 10-year-old children were required to choose either a red or a green light by making one of two responses. Duration of the chosen light was either 2, 4, 8, 16, or 32 sec, and was varied within Ss. Frequency of alternation was greater for 7-year-olds than for 4- and 10-year-olds, while the latter two groups did not differ. In addition, frequency of alternation decreased across trials but did not vary as a function of stimulus duration.*
- Hull (1943) postulated that when an organism makes a response, a quantity of reactive inhibition (I_R) is built up which reduces the probability that the response will recur. The total amount of I_R produced for a given response is assumed to be an increasing function of the number of occurrences of the response, and of the amount of work involved in making the response. I_R is assumed to dissipate spontaneously with the passage of time so that the amount of I_R which remains after the occurrence of a response is a decreasing function of the amount of time which has passed since the response occurred. Since the interval between responses increases as stimulus duration (STD) increases, the prediction can be derived from Hull's (1943) model that frequency of alternation will be a decreasing function of STD.
- Glanzer (1953) postulates that a quantity of stimulus satiation (I_S) develops in each successive moment that an organism perceives a given stimulus, and that I_S reduces the organism's tendency to respond to that stimulus. I_S is assumed to dissipate with time when the stimulus is not present. Thus, if intertrial interval (ITI) is constant, longer STDs ought to lead to more frequent alternation than shorter STDs, as a result of the accumulation of a greater quantity of I_S during the longer STD.
- Studies by Croll (1966) and Rabinowitz (1965) involving STDs of 3, 6, and 9 sec, and 1.5 and 4 sec, respectively, have failed to confirm either of these predictions. A significant STD effect was not found in either study. Significant STD effects were obtained, however, by Iwahara & Sugimura (1959, Experiment 2, Experiment 3) in two experiments employing STDs of 1.5, 10, and 30 sec, and 1.5 and 10 sec. Frequency of alternation was found to be an increasing function of STD. The results of this study cannot be directly compared with those of Croll (1966) and Rabinowitz (1965) since it differed from them in several respects. First, the latter two studies involved 4- to 5-year-old Ss and 8- to 9-year-old Ss, respectively, while the former study involved 15- to 19-year-old Ss. Age has already been demonstrated to be an effective variable in determining frequency of alternation in children (Weir, 1964, 1967). Second, STD and response duration

Children's response alternation as a function of stimulus duration, age, and trials