The transfer of interitem associations in serial learning*

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Ninety Ss were assigned randomly to learn one of three serial lists followed by the same paired-associated (PA) list. Twenty-seven additional Ss learned the PA list only. The pairs were composed of adjacent items in the first serial list, of nonadjacent items in the second, and of items irrelevant to the third serial list. The PA performance of Ss who learned the first serial list was superior to those who learned either the second or the third list and to those who did not receive any serial learning. All serial learning was effected by the varied starting position method (VSP). Results indicate that interitem associations were formed under VSP and positively transferred to PA learning. The failure of such transfer under the constant starting position method (CSP) is attributed to the masking effects of multiple chaining and serial position cues, both of which are stronger under CSP than under VSP.

Many S-R theorists, accepting the position of Hull (1935), have considered serial learning as a process of establishing S-R connections between adjacent items in a serial list. Primoff (1938) and Young (1959, 1962) tested this hypothesis by having Ss learn a PA list in which each pair consisted of adjacent items in an already well-practiced serial list. These studies failed to show positive transfer from serial to PA lists and were interpreted as evidence against Hull's hypothesis that serial learning is a matter of interitem association. Adopting this interpretation in its strongest form, Ebenholtz (1963) and Slamecka (1964) rejected any role for interitem associations in serial learning. They concluded that the primary determinants of serial learning are serial position cues and response availability.

The above studies, however, presented the serial list by the standard constant starting position method (CSP). That is, each trial was begun by the same stimulus item; hence, the serial position of each item remained constant throughout serial learning. CSP obviously allows Ss to form associations between items and their respective serial positions. Since item positions in PA learning are generally not the same as in the serial list from which they are derived, serial position effects should interfere with subsequent PA learning.

This paper proposes that interitem associations are formed during serial learning and that they positively transfer to subsequent PA learning in which the pairs are composed of

adjacent items in the serial list. Such positive transfer, however, may have been masked in the above studies by the interfering effects of serial position cues conditioned during CSP serial learning. Furthermore, CSP permits considerable chaining. That is, as a high degree of CSP serial learning is achieved, the effective stimulus for a particular response becomes not an individual item, but a chain of items preceding that response (Youssef, 1967). Since PA learning ordinarily involves only individual associations, such multiple chaining should mask the positive transfer of interitem associations.

The authors hypothesized that these two masking effects, namely, serial position cues and chaining, should be much weaker when serial learning is presented by the varied starting position method (VSP), which effects serial learning by maintaining the same serial order of items while varying the starting position on each trial (Bowman & Thurlow, 1963; Keppel, 1964; Nelson, 1967; Shuell & Keppel, 1967). In fact, one set of conditions in this study is quite similar to some conditions in the experiment of Shuell & Keppel (1967). VSP reduces serial position effects because, as the starting position changes from trial to trial, so do all the serial positions of subsequent items; hence, serial positions become unreliable cues for serial learning. It also reduces chaining effects. By breaking the chain on every trial, VSP serial learning increases the probability of the individual item alone becoming the effective stimulus for a particular response. Specifically, it is hypothesized that positive transfer due to relevant interitem associations will obtain from VSP serial learning to subsequent PA learning in which the pairs are composed of adjacent items in the serial list.

SUBJECTS

The Ss were 117 Eastern Michigan

University students.

MATERIALS

Three serial lists and one PA list were used. The first serial list (adjacent) consisted of 16 highly frequent nouns (Thorndike & Lorge, 1944). The second serial list (nonadjacent) consisted of the same items as List 1, except that the words were arranged in a different serial order. The third serial list (learning to learn control) consisted of another set of 16 highly frequent nouns which were selected from the same source. Prior to the present experiment, these lists were tested on another group of Ss and were found not to be significantly different in serial learning difficulty ($F = 1.27$, $df = 2/42$, $p > .25$). The PA list consisted of eight pairs of nouns. Each pair was composed of two items which were adjacent in the first serial list and nonadjacent in the second serial list. Each item appeared in the PA list as either a stimulus or response, but not both.

PROCEDURE

Ninety Ss were assigned randomly to learn one of the three serial lists to a criterion of either 15 or 30 trials, with the restriction of having 15 Ss in each group. The starting position on each trial of serial learning was varied randomly. Twenty-seven Ss, however, received no serial learning and were divided randomly into three groups, with the restriction of having nine Ss in each group. This division was made to satisfy a balanced 3 by 3 factorial design (three lists—adjacent, nonadjacent, and learning to learn—and three degrees of serial learning—0, 15, and 30 trials). To equate for item familiarity, all Ss were given, prior to the PA learning, free recall training on the 16 words to be used in the PA task.

The pairs of the PA list appeared in four different random orders. The entire set of pairs appeared first, one pair at a time, followed by the entire set of stimuli, one stimulus at a time. Standard instructions were given for the free recall and PA tasks. Standard serial learning instructions were slightly modified to suit VSP.

Thus, this experimental design bears some resemblance to that of Shuell & Keppel (1967) in employing the VSP method and in permitting opportunity to compare the adjacent groups with their respective learning-to-learn controls. However, there are several significant differences between the two designs. The most important differences are that the present study: (1) controls response availability for all groups and (2) uses nonadjacent groups for comparison with both their adjacent and their learning-to-learn counterparts. The first was done in an attempt to eliminate contamination

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between response availability and the positive transfer of interitem association (Postman & Stark, 1967). The second was included in order to test the generality of transfer (i.e., both negative as well as positive) from serial to PA learning.

RESULTS

Inspection of the PA performance data revealed a ceiling effect due to the use of a short and easily learned PA list. Because of this ceiling effect, only the first few PA trials were sensitive to transfer effects; hence, analyses presented here were limited to the number of correct responses on the first two PA trials.

The hypothesis that interitem associations are formed during VSP serial learning and that they positively transfer to pairs composed of adjacent items in the serial list is supported. Orthogonal polynomial comparisons for the three adjacent groups yielded a significant linear trend as a function of degree of serial learning ($F = 10.18$, $df = 1/108$, $p < .01$). Orthogonal polynomial comparisons also yielded a significant quadratic trend ($F = 5.39$, $df = 1/108$, $p < .05$). This quadratic trend is consistent with the authors' expectations that interitem association effects would level off after a high degree of serial learning has been attained. The prediction of a negative slope for the function depicting the PA performance of the nonadjacent groups seemed as a corollary to the above hypothesis. For these groups, the interitem associations accrued during serial learning should constitute a source of interference in PA learning. This prediction, however, is not supported by present results. The trend, although slightly short of statistical significance is contrary to prediction. The function tends toward positive, instead of negative, linear slope ($F = 3.59$, $df = 1/180$, $.10 < p < .05$).

The expectation that learning-to-learn effects would obtain is generally supported. Orthogonal polynomial comparisons yielded a significant quadratic component ($F = 5.39$, $df = 1/108$, $p < .05$) but not a significant linear trend ($F = 2.49$, $df = 1/108$, $p > .10$). It seems that the function does not level off as predicted, but drops after the 15th trial of serial learning. Further analyses, mainly based on t -tests, indicate the following: the PA performance of any group with any type and any degree of serial learning is superior to the group that had no serial learning at all. The PA performance of each group with adjacent serial learning, be that 15 or

30 trials, is superior to that of its nonadjacent and its learning-to-learn counterparts. Each nonadjacent group does not differ significantly from its learning-to-learn counterpart (the largest t is 1.44, $df = 28$, $p > .10$).

DISCUSSION

The performance of the adjacent groups supports the hypothesis that interitem associations are formed in VSP serial learning and that they transfer to subsequent PA learning. The performance of the nonadjacent groups, however, is contrary to that hypothesis. Thus, the performance of the adjacent groups is consistent with the conclusions of Shuell & Keppel (1967), while that of the nonadjacent groups is not. The first question is why do the groups with nonadjacent serial learning show no decrement in the PA performance as compared with their learning-to-learn control? Analysis of the performance on the serial task sheds some light. The serial learning performance of each nonadjacent group is superior to that of its adjacent or learning-to-learn counterpart. Since previous findings indicate that the three serial lists are of equal difficulty, it is possible that the nonadjacent groups, be they assigned to 15 or 30 serial trials, were superior to the other groups in their general learning ability. Taking the performance of the first 15 serial trials as covariate, an analysis of covariance was conducted on the PA performance of the six groups who took serial learning of any kind. Because of the extreme heterogeneity in regression ($F = 8.27$, $df = 5/78$, $p < .001$), the covariance method was found to be inappropriate.

The nonadjacent groups who received serial learning may have also been superior to their learning-to-learn counterparts on response availability and stimulus differentiation. Although they were equal on the number of correct responses on the final free recall trial, the nonadjacent groups, because of their extensive serial practice on the items, may have been superior to the learning-to-learn groups on item familiarity in terms of lower response latency. Thus, the nonadjacent groups' general learning superiority, their stronger response availability, and their greater stimulus differentiation may have mitigated against the predicted interference of inappropriate interitem associations.

The second question is whether VSP is representative of man's experience with serial phenomena. In real life, it is the rule rather than the exception that man begins a certain sequence of events at different points on different occasions. Thus, VSP is a fair

representative of everyday serial learning.

The third question is whether VSP results in positive transfer because it reduces masking effects prevalent under CSP or simply because it leads to stronger interitem association per se. This study does not provide an answer to this question.

CONCLUSION

Interitem associations are formed in serial learning under VSP and positively transfer to relevant PA learning. Such transfer has failed to obtain under CSP because masking effects of chaining and serial position cues are stronger under CSP than under VSP. An alternative interpretation would be that VSP leaves Ss no other recourse for serial learning but interitem associations. The positive transfer obtained under VSP may be attributed then not only to a reduction in interference, but also to an increase in the interitem associative strength per se.

REFERENCES

- BOWMAN, R. E., & THURLOW, W. R. Determinants of the effect of position in serial learning. *American Journal of Psychology*, 1963, 76, 436-445.
- Ebenholtz, S. M. Serial learning: Position learning and sequential associations. *Journal of Experimental Psychology*, 1963, 66, 353-362.
- HULL, C. L. The conflicting psychologies of learning—A way out. *Psychological Review*, 1935, 42, 491-516.
- KEPPEL, G. Retroactive inhibition of serial lists as a function of the presence or absence of position cues. *Journal of Verbal Learning & Verbal Behavior*, 1964, 3, 511-517.
- NELSON, L. The effect of prior response learning upon subsequent paired-associate learning under constant or varied orders of presentation. *Journal of Verbal Learning & Verbal Behavior*, 1967, 6, 78-83.
- POSTMAN, L., & STARK, K. Studies of learning to learn: IV. Transfer from serial to paired-associate learning. *Journal of Verbal Learning & Verbal Behavior*, 1967, 6, 339-353.
- PRIMOFF, E. Backward and forward associations as an organizing act in serial and in paired associate learning. *Journal of Psychology*, 1938, 5, 374-395.
- SHUELL, T. J., & KEPPEL, G. A further test of the chaining hypothesis of serial learning. *Journal of Verbal Learning & Verbal Behavior*, 1967, 6, 439-445.
- SLAMECKA, N. J. Inquiry into the doctrine of remote associations. *Psychological Review*, 1964, 71, 61-76.
- THORNDIKE, E. L., & LORGE, I. *The teacher's word book of 30,000 words*. New York: Bureau of Publications, Teachers College, Columbia University, 1944.
- YOUNG, R. K. A comparison of two methods of learning serial association. *American Journal of Psychology*, 1959, 72, 554-559.
- YOUNG, R. K. Tests of three hypotheses about the effective stimulation in serial learning. *Journal of Experimental Psychology*, 1962, 63, 307-313.
- YOUSSEF, Z. I. Association and integration in serial learning. *American Journal of Psychology*, 1967, 80, 355-362.