EXTRASERIAL CUES IN VERBAL LEARNING

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Research in verbal learning has been carried out in the past as a means of investigating forms of learning which are integral parts of the educational process. Typically, two basic paradigms have been utilized to this end: Serial learning (SL) and paired-associate (PA) learning. In the former, the subject (S) is required to learn the constant order in which a series of items appear. Basically, the S must anticipate each list member one position before it appears in the sequence. Thus, each item in the sequence, except the first and last items, serve both as a cue (stimulus) for the succeeding item and a response to the immediately preceeding item. The first and last items serve only as a stimulus and response, respectively. On the other hand, the PA paradigm involves the formation of associations among pairs of items. As typically studied, several stimulus-response pairs first are presented together in varying orders for study and then the S must give from memory the appropriate response when shown just the stimulus term of each pair (Battig & Brackett, 1961).

Much recent work in verbal learning has been concerned with a seperation of what has been termed the "nominal" and "functional" stimuli. The nominal stimulus is that which the experimenter (E) designates as being the appropriate cue for a response whereas the functional stimulus is that cue which the learner uses to elicit the response, which may or may not be identical with the nominal stimulus. One class of investigations which have been concerned with the evaluation of nominal and functional stimuli have been termed "cue selection" studies (Underwood, 1963). However, these studies have been largely restricted to the PA learning paradigm. The purpose of the present research is to investigate cue utilization in SL.

Since the present method relies heavily upon techniques previously employed in PA studies of cue selection, it is advantageous to review first the principal procedure and findings from the PA studies. In these studies, a list of compound or dual stimuli paired with a single response first is presented to the S for learning. Then, after reaching some performance criterion, a second transfer list is practiced upon. The transfer task basically consists of learning the pairs once again but with only one component of the compound stimulus present. Thus, performance on the component stimuli relative to each other has been taken as indicative of the strength of association of each stimulus element with the responses: the stronger the association, the more "functional" was that component during original learning.

The results from studies using the above transfer test indicate that Ss tend to use as the more functional stimulus, the most distinctive or meaningful element of the compound stimulus (Cohen & Musgrave, 1964, 1965, 1966; Jenkins, 1963; Jenkins & Bailey, 1964; Newman & Taylor, 1963; Sundland & Wickens, 1962; Underwood, 1963; Underwood, Ham & Ekstrand, 1962; Weiss & Margolius, 1954; Young et al., in press). For example, given a compound stimulus of a nonsense syllable and a color background, Ss will select the color as the functional stimulus (Underwood et al., 1962). Such a selection process, however, is probably not an all-or-none affair since correct responses are evidenced for both elements of the stimulus compound on the first transfer trial. Rather, the magnitude of the results obtained allows speculation of some type of configurational stimulus in which components are responded to in some weighted manner. Spear, Ekstrand and Underwood (1964) believe an association to develop between stimulus components because of contiguity alone. In any event, it is clear that the greater the discrepancy in ease of learning between the components of the compound, the more probable it is that S will rely more heavily upon the easier of the elements as the functional stimulus.

A final PA study of relevance is that of Brown, Battig and Pearlstein (1965). Using a procedure of successive-addition of stimulus elements throughout learning, these investigators found consistently fewer errors, particularly late in learning, for this as compared with a control group who were presented with all elements of the stimulus term at the outset of learning. Brown, et al., (1965) interpret these results as indicating that additional stimulus cues are learned during and following intermediate stages of learning as a means of combatting intralist interference. On the other hand, Ss in the control condition probably attended to most or all of the stimulus elements from the outset of learning, thereby producing intralist interference in learning. Thus, taken together, the results from previous PA studies indicate cue selection to increase both with an increase in intralist interference and relative meaningfulness of the extrastimulus cues. It is the generality of these notions that the present thesis is intended to test in SL.

The distinction between nominal and functional stimuli must be modified in SL because its procedure prevents an active selection process. Specifically, in SL, the _S_'s correct response necessarily includes all elements of the primary serial items since each item in the list serves both as a stimulus and a response. In addition, however, extrastimulus cues also may develop stimulus properties. For the remainder of this thesis, the term _extraserial cues_ will be used to refer to those added elements in a serial list which are present during SL but which do not comprise a requisite part of the _S_'s responses. The term _primary elements_, on the other hand, are reserved for the required materials to be learned.

It is well documented that the difficulty of serial learning increases to a maximum in the middle of the list and then decreases at the ends (Deese, 1958, p. 172). On the basis of the results obtained in PA learning, it might be expected that the tendency to respond to extraserial cues would be greatest in the last learned middle positions of a serial list wherein intralist interference is presumably maximal. At the ends of the list, even low meaningful primary serial elements ought to be fairly discriminable by virtue of their isolated positions (Murdock, 1960). Brown, Rubin and Volkuwitz, (1965) supported the above hypothesis using low meaningful verbal trigrams as primary serial elements and colored backgrounds as extraserial cues. Specifically, after original learning of the serial list, a PA transfer task showed relatively greater associative strength between adjacent colors and trigrams than trigrams and trigrams in the middle of the list, but the opposite relationship at the beginning and ends of the list. However, no systematic differences in transfer performance were obtained when the primary serial items were meaningful words, in agreement with the PA results discussed above. Such transfer task performance in SL strongly suggests that increases in difficulty of learning produced either by the serial position effect or meaningfulness of material, leads to a greater tendency for S to utilize extraserial cues as a means of reducing intra-list interference. Furthermore, acquisition of the original serial list was hindered by the presence of color cues when the primary elements were of low meaningfulness but not when the primary serial items were highly meaningful. Thus, at least for difficult primary serial elements, the Ss perhaps were attempting to incorporate both these and extraserial cues from the outset of learning as was suggested also to account for the decrement in the successive-addition PA study of Brown, Battig & Pearlstein (1965). Findings similar to those of Brown, Rubin and Volkuwitz (1965) also were obtained in an earlier study by Kausler and Trapp (1963) using digits as extraserial cues and nonsense syllables as primary elements. However, because a subsequent transfer task was not employed, the associative strengths between adjacent extraserial cues and primary elements could not be assessed. Thus, the parallels between cue selection in PA learning and cue utilization in SL are very apparent. In both instances, with increasing difficulty in learning there is an increased tendency for S to rely upon extrastimulus cues, even though overall learning may be retarded thereby.

The present study was designed to provide information about the relative utilization of extraserial cues at varying stages of SL. Specifically it was hypothesized that if extraserial cues are ommitted until beginning and end items in the serial list are acquired, then acquisition of the entire list should be facilitated. In this manner, Ss are prevented from unnecessarily attending to extrastimulus cues at the beginning of learning, where such cues may serve to produce substantial stimulus competition with the primary elements of the list (Brown, Battig & Pearlstein, 1965). On the other hand the late addition of extraserial cues should allow their effective utilization within the middle serial positions where intralist interference is maximal. Accordingly, it was predicted that a group which has extraserial cues inserted late in learning should attain criterion at a rate faster than groups who have a) cues present throughout learning, b) cues present during early stages of learning but absent during later stages and c) cues absent throughout learning. Furthermore, this "forced" attention to extraserial cues should be evident in a PA transfer task of the type employed by Brown, Rubin and Volkuwitz (1965).

METHOD

Subjects

The 144 college student Ss enrolled in an introductory psychology course at Kansas State University completed the two-hour experiment for extra class credit. All Ss were naive with respect to verbal learning experiments and were assigned to the experimental groups according to a predetermined unsystematic sequence which insured that the groups were filled at the same rate. Data from two additional Ss were not used in the analyses because of failure to follow instructions properly.

Serial Learning

All Ss first practiced upon an identical serial list of 12 nonsense syllables using standard anticipation procedure. On a Stowe Memory Drum, each of the 12 nonsense syllables was presented one at a time, at a 3-sec. rate, and S was required to anticipate the syllable which came immediately after the one he was viewing. The successive presentation of all 12 syllables constituted a trial, and an asterisk placed at the beginning of the list served as a cue for the start of a trial (Anticipation). A 6-sec. rest interval was maintained between each trial. Spelling was required of all responses.

108 of the Ss were divided into four groups of 27 Ss each, which studied the serial list under one of four extraserial cue conditions: no-color (N); color (C); color only at the beginning of learning (CB); and color only at the end of learning (CE). The procedure used for each of the four

conditions was as follows:

<u>Condition</u> <u>N</u>. <u>S</u>s learned the serial list on a uniformly white background.

<u>Condition</u> <u>C</u>. <u>S</u>s learned the serial list with each trigram consistently presented on a differently colored background throughout learning.

<u>Condition</u> <u>CB</u>. <u>S</u>s practiced upon the list with colored backgrounds (as in Condition <u>C</u>) until they reached a criterion of 7-9 items correct on a single trial, at which time the colors were removed and learning continued (as in Condition <u>N</u>).

<u>Condition</u> <u>CE</u>. <u>S</u>s practiced upon the list without colored backgrounds (as in Condition <u>N</u>) until they reached a criterion of 7-9 correct on a single trial, at which time colors were added and learning continued (as in Condition <u>C</u>).

A 7-9 correct criterion was employed since for the average <u>S</u> this should correspond to the point in SL where the middle have not yet been responded to correctly.

The changed lists for the <u>CB</u> and <u>CE</u> Conditions differed from the initial lists only in the presence or absence of color. Upon reaching a criterion of 7-9 correct items on a single trial, all <u>S</u>s in each of the four SL conditions received a 1- min. rest period. During this time, the <u>S</u>s in Conditions <u>CB</u> and <u>CE</u> were informed of the color change. The instructions emphasized, however, that neither the order of the trigrams nor the trigrams themselves would be changed in any way. Final criterion performance for all Ss in SL was the attainment of two consecutive errorless trials.

Upon entering the experimental room, each S was seated in front of a black screen, which shielded him from the E and the apparatus, and was given, via tape recorder, standard SL instructions (see Appendix 1). The first three Ss in each SL condition were informed that color may be added or removed at some time during learning. For all remaining Ss, the instructions were altered with this information deleted. It was felt that the original instructions tended to bias the Ss to either attend to or ignore the extraserial cues within the SL conditions.

Paired-Associates Learning

After reaching criterion on SL, the Ss in each of the four serial conditions were given a 1-min. rest during which time assignment was made to each of three transfer lists on the basis of SL performance. Specifically, within each of the SL conditions, three groups of 9 Ss were matched in terms of mean trials to SL criterion and variance about the mean. The matching technique was used only within, not across, SL conditions.

In PA learning, all Ss practiced upon one of three 6-pair transfer lists which were derived from the previous serial list by pairing adjacent serial items. Response terms were always the same even-numbered trigrams from the serial list but without colored backgrounds. The stimulus terms for the three lists differed, however, being either the immediately preceding trigram and color (TC), the preceding trigram (T), or the preceding color (C) to the response term. The pairs were presented manually on index cards by E using the study-test (recall) method of learning. Each trial first consisted of the individual presentation of the six stimulus-response pairs for study, followed by the presentation of each stimulus term alone for testing, i.e., response-term recall. The rate of presentation on both study and test series was 4-sec. with 12-sec. intra- and intertrial intervals. All Ss were required to spell the response terms on both study and test series. The E always shuffled the cards following their presentation in order to prevent serial learning of the pairs.

After reading of the PA instructions (see Appendix 1), in which the nature of the stimulus term composition was explained but not the technique for pairing serial list items, the S was seated behind a black screen, again shielded from E and PA learning commenced.

Three additional groups of 12 Ss, who had not practiced on the original serial list, also learned either the TC, T or C transfer list. These control groups, apart from introductory remarks about the nature of verbal learning studies, received exactly the same instructions as all transfer groups. Although not matched for initial learning ability, these additional groups were included to provide a control comparison between the transfer conditions. Criterion performance for all PA conditions was, as in SL, two consecutive errorless trials.

<u>Post-experimental Questioning</u>

Following attainment of the PA criterion, all <u>S</u>s were asked several questions concerning the nature of their use or non-use of the extraserial cues within SL and PA learning, where applicable, and of associative processes used in learning (see Appendix 1). Before leaving the Laboratory, all <u>S</u>s who learned in the presence of color cues were tested for color blindness by the Isihara Pseudiosochromatic Plates. Data from 4 <u>S</u>s were discarded on the basis of the test and the next 4 <u>S</u>s who appeared in the laboratory served as replacements.

<u>Materials</u>

The same list of 12 Low-medium association value trigrams was used for all <u>S</u>s both in SL and PA learning. Archer (1960) association values of the trigram ranged from 31% to 35% with a mean of 32.5%. The list also was of low formal similarity, i.e. with minimal letter duplication between trigrams. In the construction of the list, it was insured that no letter appeared twice in any given trigram and that no two trigrams began or ended with the same consonant. Three different serial orders of the 12 trigrams were constructed and practiced upon by one-third (9) of the <u>S</u>s in each of the four SL conditions. No letters were duplicated within any one-third (four trigrams) of each of the three lists. For <u>S</u>s learning under the color conditions, three different serial orders of 12 colors were combined with the three trigram orders. The trigrams for each of the three serial lists were typed on memory drum tape and were either all on a uniform white background for Condition N or surrounded by 1 X 1¼ in. colored backgrounds for Conditions C, CB and CE. The 12 colors used, chosen on the basis of discriminability and apparent ease of naming, were pasted on the drum tape over the trigrams. A window cut in each colored rectangle allowed the S to see the trigram. Appendix 2 gives a listing of the trigrams and colors used in the research.

The stimulus-response pairs for the three PA transfer lists were presented on 3 X 5 in. white index cards. The stimulus elements were either typed (trigrams) or pasted on (color) the cards. Response terms, in all cases, were typed on the cards. Nine PA transfer lists were constructed in all, three for each serial order representing the TC, T and C conditions, with an equal number of Ss (12) learning each list. An equal number of PA Control Ss (4) also learned one of the nine PA lists. The PA lists are presented in Appendix 2.

RESULTS

Serial Learning

To evaluate the comparability of the seperate SL conditions, comparisons were made between Conditions C and CB and between N and CE in terms of the number of trials and total errors (incorrect recalls plus ommissions) required to acquire 7-9 items correct on a single trial. Up to this criterion, these respective groups learned under identical conditions. Conditions C and CB differed little in terms of either trials or errors and the differences for both measures were insignificant by analysis of variance (both F's < 1; the .05 level was used as the criterion of significance for all analyses reported herein). Although Condition N (11.97) and Condition CE (12.70) were fairly well matched with respect to trials, Condition CE made more mean total errors (110.15) than did Condition N (101.33). However, these differences were similarly insignificant, F's < 1.

Number of total errors to criterion during SL (two errorless trials) was tabulated seperately for each S and constituted the principal measure of performance. The number of errors made in each serial position also was tabulated seperately for each S. Mean total errors for the four SL conditions were as follows: N (151.00); C (151.67); CB (147.89); and CE (166.41). Although Condition CE consistently made a greater number of errors than either Condition N, C or CB, this difference was not significant, $F(1,104) = 1.08$. The distribution of total errors across the 12 serial positions for each condition conformed to the classical bowed serial position curve and resulted in a highly significant overall Position effect, $\underline{F}(11,1144) = 83.80$. However, the Position X Condition interaction fell far short of significance, $\underline{F} < 1$.

Basically, the same results as reported for total errors were obtained for <u>before errors</u> (the total number of errors preceding the first correct response to each position) and <u>after errors</u> (the total number of errors following the first correct response to each position), as well as for number of trials to criterion. Furthermore, inspection of the <u>substitution error</u> (responses which are correct but made to an incorrect serial position) and <u>ommission error</u> (failures to respond) distributions across the 12 serial positions revealed the four SL conditions to be indistinguishable from one another. Examination of the learning curves for each condition similarly showed little difference between them.

A comparison of total errors during SL made one trial before the rest interval and those made on the succeeding trial indicated that this interval possibly produced an immediate but temporary decrement in performance. Specifically, a significant decrease of about one correct response per <u>S</u> occurred for all conditions following the rest interval in comparison to the preceding trial, $\underline{F}(1,96) = 31.84$. However, the four SL conditions were virtually identical to one another with respect to total errors required to reach criterion after the interval.

In summary, all measures show the four conditions not to differ significantly from one another during SL. Moreover, the absence of a significant interaction between conditions and serial position precludes any suggestion of differential cue utilization across the 12 serial positions of the list.

Paired-Associate Learning

The mean number of total errors for each transfer condition are presented in Table 1, seperately for each SL condition. Overall, Condition CE made the greatest number of errors and Condition CB the fewest, with Conditions C and N occupying the two intermediate positions respectively. Although the overall differences between SL conditions were insignificant, $F(3,96) = 1.30$, the difference between Condition CE and combined C, N and CB performance was significant, $F(1,96) = 18.39$.

Table 1 also shows better performance under the C than either the TC or T Transfer condition. Although the differences between the three transfer lists were insignificant, $F < 1$, pairwise comparisons revealed significantly fewer errors under the C than the combined TC and T Transfer conditions, $F(1,96 = 7.37$.

Also provided in Table 1 are the performance measures for the three PA Control conditions. By comparing the means presented with those of the appropriate transfer list, it is easily seen that prior SL had a beneficial effect upon subsequent PA learning. That is, the PA Control Ss made significantly more overall errors than did PA Transfer Ss, $F(1,138) = 52.59$. The superiority of the C over the TC and T control lists also proved to be significant, $F(1,27) = 4.41$. Results equivalent to those reported above for total errors were obtained both for before and after errors.

Table 1

Mean total errors on paired-associate learning

	SL Condition					PA
PA List	N	C	CB	CE	Total	Controls
TC	11.11	8.67	5.56	12.89	9.56	26.08
T	8.22	9.00	11.89	13.89	10.75	28.92
C	7.11	11.33	5.22	9.22	8.22	15.25
Total	8.81	9.67	7.56	12.00	9.51	23.42

In order to evaluate differential cue utilization across the six pair positions, trend analyses of variance (Edwards, 1964, p. 224-250) were performed seperately for each SL condition. The results are summarized in Table 2 and the error distributions across the six pair positions on each transfer list for Conditions N, C, CB and CE are illustrated in Figures 1A-1D respectively.

The transfer functions for Condition N are depicted in fig. 1A. Clearly, the differential difficulty of learning according to serial position in SL exerted a strong effect upon the succeeding transfer performance. All transfer conditions generally show poorer performance in middle than beginning and end positions, except for a decrease in errors in the middle pair position of the T Transfer condition, leading to a significant quartic component of the Transfer X Position interaction. No explanation for the dip in the T Transfer function is immediately apparent. Both the quadratic and quartic components of the overall Position effect were significant.

Of particular interest are the transfer functions obtained for Condition C, and depicted in Fig. 1B. As can be seen, the transfer functions for TC and T show a bowed serial position curve, whereas the C Transfer function is exactly the inverse in accordance with the original hypothesis. That these functions deviate reliably from one another is indicated by a significant quadratic component of the Transfer X Position interaction.

The results for Condition CB are presented in Fig. 1C. Compared to the inverted U-shaped transfer function for TC and

Table 2

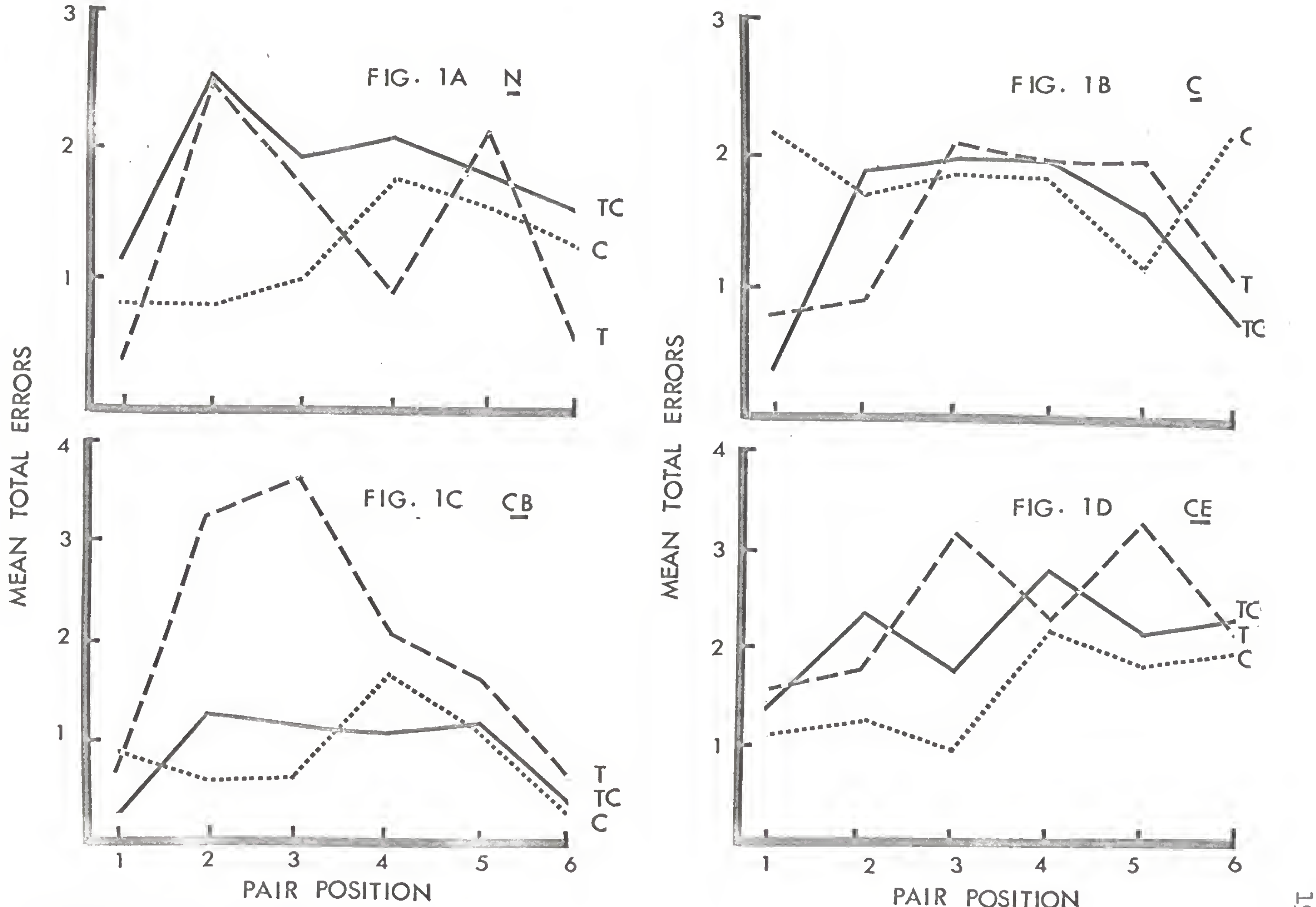
Analysis of variance summary table on paired-associate learning for total errors.

SL Conditions

Source	df		N		C		CB		CE	
			MS[1]	F	MS	F	MS	F	MS	F
Total	161									
Between Ss	26									
Transfer	2		6.40	< 1	3.17	<1	21.17	2.59	9.06	<1
Ss/Groups	24		16.19		9.33		8.19		14.87	
Within Ss	135									
Position	5		5.30	3.44*	3.03	1.32	9.14	4.86*	3.90	1.25
Linear		1	0.93	<1	0.65	<1	1.43	<1	13.21	2.98
Quadratic		1	13.50	8.76*	12.89	5.62*	41.29	21.96*	4.59	1.16
Cubic		1	0.92	<1	0.01	<1	1.25	<1	1.07	<1
Quartic		1	10.95	7.10*	-	-	-	-	-	-
Residual		1	0.18	<1	0.81	<1	0.87	<1	0.31	<1
Tr. X Pos.	10		2.75	1.78	2.99	1.30	4.71	2.50*	2.26	<1
Linear		2	1.72	1.12	1.33	1	2.27	1.21	0.07	<1
Quadratic		2	1.76	1.14	9.96	4.35*	7.77	4.13*	1.86	<1
Cubic		2	2.29	1.49	1.16	<1	11.35	6.04*	0.57	<1
Quartic		2	6.51	4.22*	-	-	-	-	-	-
Residual		2	1.47	<1	1.25	<1	1.08	<1	4.41	2.35
Error	120		1.54	1.54	2.29		1.88		3.44	
Linear		24	-		-		-		4.44	
Quadratic		24	-		-		-		3.95	
Cubic		24	-		-		-		5.06	
Residual		48	-		-		-		1.88	

1 MS indicates Mean Square.

* Significant at or beyond the .05 level.



Figures 1A, 1B, 1C, and 1D.

t, the transfer function for C is markedly skewed to the right. The Transfer X Position interaction proved to have both significant quadratic and cubic components.

The three transfer functions for Condition CE, shown in Fig. 1D, all show an increase in errors across the six pair positions. However, neither the overall linear effect nor the linear component of the Transfer X Position interaction proved to be significant.

In order to perform similar analyses on the PA Control conditions, the six pairs were arranged in exactly the same orders as used for the Transfer conditions. The only difference than between the PA Control conditions and the Transfer conditions was the ommission of prior SL for the Ss in the former condition. All orthogonal components both of the overall position effect and the Control X Position interaction proved to be nonsignificant, thus assuring that the transfer functions presented in Figs. 1A - 1D were not the result of a systematic bias inherent in the pairs themselves, i.e., differential pair difficulty.

To summarize, a bowed serial position curve is fairly typical of the TC and T Transfer conditions for all SL conditions with the exception of CE. For Condition CE, the two curves were essentially horizontal in form. Thus, in general, the middle positions of the list, relative to the beginning and end positions, provide the most difficulty for learning. On the other hand, the C Transfer condition displayed both differential and non-differential intraserial effects during PA learning, depending upon the kind of prior SL.

Post-Experimental Questioning

Several questions were asked of all Ss after the completion of PA learning (see Appendix 1): the nature of these questions may be inferred from the results reported below. In all cases, a dichotomous reply (i.e., Yes-No) was used to facilitate tabulation and the percentage of Ss responding to one of the alternatives is reported. The difference between percentages was tested by a t-test of the difference between two proportions (Smith, 1962, p. 79).

S's who learned the serial list in the presence of color cues first were asked if they found the colors to be helpful during SL. Only 29.6% of the Condition CE Ss responded positively as compared to 56.0% and 57.7% for Conditions C and CB, respectively. Condition CE differed significantly from both Condition C, $t = 2.36$, and Condition CB, $t = 2.67$. Similarly, in PA learning, the percentage of Ss who believed the colors to be helpful decreased progressively from Condition C (94.1%) through Conditions CB (88.2%) and N (76.5%) to Condition CE (68.8%), although the only significant difference occurred between Conditions C and CE, $t = 2.00$.

In an attempt to discover how the Ss in Conditions CB and CE anticipated the possible change in ease of learning after color cues had been added or deleted, they were asked if they believed that learning would be more difficult after than it was on the trials before the interval. Of the Condition CE Ss, 53.8% apparently thought that the removal of cues would adversely affect their performance, whereas only 24.0% of the

Condition CE *S*s believed that addition of colors would hinder their performance. The difference between these two conditions proved significant, $t = 2.34$.

In addition, questions were asked of all *S*s about the techniques used in pairing the serial colors and/or trigrams for use in PA learning. Virtually all *S*s were aware of the rules used in making up the pairs and no significant differences were found between the four SL conditions for these questions, all t's ≤ 0.63.

DISCUSSION

The major hypothesis of the present research was not supported. There exists no evidence to infer that the addition of extraserial cues late in learning served either to facillitate or hinder acquisition of a serial list. The consistently poorer performance by Condition CE appears largely attributable to sampling differences between this and the other SL conditions. Specifically, it was noted that Condition CE was inferior to Condition N immediately prior to color-cue addition. As the transfer Ss in Condition CE who learned the C list did not present a systematic error distribution across the six pair positions, there also exists no evidence for differential strength of association between adjacent colors and trigrams in any serial positions. Moreover, the questionnaire data supports the interpretation that Ss in Condition CE attempted to ignore the added cues during SL. It thus would appear that those Ss believed it advantageous to continue learning the serial list after the interval in the same manner as they had when color was absent from the list. Perhaps if the instructions had emphasized that knowledge of the cues and their respective serial positions would be important at a later time during the experiment, the utilization of these extraserial cues might have been apparent in the results.

There likewise is no evidence to suggest that the removal of extraserial cues late in learning affected SL performance. The extremely small difference between Conditions CB and C points to this conclusion. Furthermore, the questionnaire data indicates that Ss in Condition CB believed the color cues to be of as much aid in SL as did Ss in Condition C who had colors present throughout learning. Since no significant adverse effect upon SL performance was found after the removal of color from the list for Condition CB, it may be concluded that the color cues apparently did not develop strong stimulus properties in the beginning and end positions of the serial list. In this connection, it is important to note that positional cues also may have been extensively involved in the serial associative process for which no controls were provided (e.g., Young, 1961).

The failure to find significant differences in SL performance between Conditions C and N is not in agreement with previous results reported by Brown, Rubin and Volkuwitz (1965) and Kausler and Trapp (1963), wherein added color served to produce a significant decrement in SL performance. However, unlike the earlier research, the inclusion of a one-minute rest interval during learning in the present study may have served to eradicate developing differences between the two SL conditions, particularly since the interval occurred at a stage of learning where interference should be maximal. Thus, to the extent that interference was greater for Condition C than N, such an interval may have allowed for a greater reduction of this interference for Condition C than N (Underwood, 1961).

In contrast to the results found for SL, the PA learning data are largely in accord with the earlier findings of Brown, Rubin and Volkuwitz (1965). The relative differences in PA associative strength after SL with color between a preceding trigram or color and the immediately following trigram indicates that extraserial cues are utilized to a greater degree in the more difficult middle than end positions of a serial list. The opposite was true for the primary (trigram) elements. That is, at the beginning and end positions, trigrams are utilized to a greater degree than in the middle positions.

The overall superiority of the PA lists in which color was a stimulus, both for transfer and control conditions alike, allows the conclusion that such a list is inherently easier to learn than either the TC or T lists. The numerical superiority of TC over T is consistent with findings by other investigators (Saltz, 1963; Weiss & Margolius, 1954) and is best interpreted by the hypothesis that trigram and color compound stimuli in a paired-associate list allows for more opportunity to reduce intralist interference via cue selection and stimulus-response differentiation. Colors as stimuli likely generate less generalization and hence response competition than do either trigrams alone or trigrams and colors combined. Only under Condition C did Transfer condition C make more errors than the other transfer lists, perhaps indicating a disruption of the stimulus context by the removal of the trigram component of the stimulus compound. A reliance by S upon a configurational (compound) stimulus is certainly in agreement with results from earlier PA studies (e.g., Underwood et al., 1962).

In summary, the results of the present study provide no evidence that extraserial cues added late in SL will benefit acquisition. Rather, such cues appear to be partially, if not wholly, ignored by the S for the remainder of SL. Furthermore, the removal of color late in learning does not hinder performance in any apparent manner. Nonetheless, color cues are shown to display stimulus properties given that they are present from the outset of learning. The extent of cue utilization, moreover, was found to vary with positional difficulty; the <u>S</u> seems to rely more heavily upon color as a stimulus in the middle than at the beginning or ends of the serial list. Thus, the present transfer task results provide further evidence for differential cue utilization in SL.

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Appendix 1

<u>Serial Learning Instructions</u>

This is an experiment in what we call serial learning which requires that you learn to anticipate the order in which a series of verbal items appear. The entire experiment will take about two hours and you will receive two class credits for your cooperation.

On the first trial, you will be shown a figure of a star followed by 12 three letter nonsense syllables. A nonsense syllable is a three letter combination which does not represent a word in the English language. Each syllable will be presented seperately in the window of the memory drum before you. Your task is to study each of the syllables as they are presented and to learn the order in which they are presented. This order will always remain the same. Each syllable including the star will be shown for three seconds.

Following the first presentation of the entire list of 12 syllables, there will be a six-second interval before the list is presented again. During this time, you will see two blank spaces on the drum. Beginning with the star, you are to try to anticipate the order of the syllables by spelling the three letters of each syllable before it actually appears in the window of the drum. For example, when you see the star, you will have three seconds in which to spell, out loud, the letters of the first syllable. At the end of the 3 seconds, the first syllable will appear in the window of the drum. This is your signal to spell the letters of the second syllable before it appears in the window. You are to follow this anticipation procedure throughout the entire list.

To summarize, always try to spell, out loud, the letters of the syllable which comes after the one at which you are looking. Moreover, never run through the list faster than the syllables are presented. That is, do not attempt to anticipate the first syllable in the list until you see the star and do not attempt to anticipate the second syllable until you see the first syllable. (Give Example) - Any Questions?

Before we begin, I should point out that each syllable may appear on a colored background, with a different colored background for each of the 12 syllables on the list. If there are no colored backgrounds to begin with, they may be inserted some time after you begin, at which time you will be told of their inclusion. If there are colored backgrounds to begin with, they may be taken away some time after you begin learning; similarly, you will be notified. Remember though, your task is to learn to anticipate the order of the syllables. If you are not sure of the correct response at any time, please guess. Any further questions?

<u>Conditions C & N</u>

We will now take a one minute break. So relax and we will resume learning in a few moments. (After one minute) Now we will begin again. The list and your task remains exactly the same. That is, you are to anticipate the order of the syllables which will be exactly the same as before. As soon as you see the star, begin anticipating the order of the syllables. We will stop when you have given two correct trials in a row. Are there any questions?

Condition CB

We will now take a one minute break. So relax and we shall resume learning in a few moments. During this time, I am going to change the windows on the drum such that the syllables will no longer have colored backgrounds. The order of the syllables will remain exactly the same as before. Your task is still to anticipate the order of the syllables. (After one minute) As soon as you see the star, begin anticipating the order of the syllables. We will stop when you have given two correct trials in a row. Are there any questions?

Condition CE

We will now take a one minute break. So relax and we shall resume learning in a few moments. During this time I am going to change the windows on the memory drum so that the syllables will now have colored backgrounds. The order of the syllables will remain exactly the same as before. Your task is still to anticipate the order of the nonsense syllables. (After one minute) As soon as you see the star, begin anticipating the order of the syllables. We will stop when you have given two correct trials in a row. Are there any questions?

PAIRED-ASSOCIATE LEARNING INSTRUCTIONS

Control Ss

This is an experiment in what we call paired-associate learning. The experimental session is about one hour long and you will receive 1 class credit for your cooperation. Paired-associate learning is very similar to learning a foreign language vocabulary. During the experiment we will be using nonsense syllables which are three letter combinations which have no meaning in the English language.

Transfer Ss

Your final task in this experiment is called paired-associate learning which is very similar to learning a foreign language vocabulary. In this task we will use the same materials as those used on the drum.

Now, on the first part of each trial, you will be shown, on seperate index cards, six pairs of items, consisting of:

(TC) A nonsense syllable and a color on the left hand side of the card and a nonsense syllable alone on the right side.

(T) A nonsense syllable on the left hand side and another nonsense syllable on the right side.

(C) A color on the left hand side of the card and a nonsense syllable on the right side.

Your task is to spell aloud the letters of the right hand syllable of each pair as it is presented and to learn to associate both members of each pair together, so that when you are later shown only the left hand member of each pair, you can give from memory the right hand syllable as a response to it.

After all six pairs have been presented, each at a 4 sec. rate, you will be shown, one by one, just the left hand

(TC) syllable and color of each pair

(T) syllable of each pair

(C) color of each pair

You are to try to respond by spelling aloud the letters of the syllable which had been previously paired with it. If you are not sure of the correct response, please guess. Do not try to learn the order in which the pairs will appear since the index cards will be shuffled after every presentation of the six cards. This constitutes one trial and the following trials will be the same. (Give Example) - Any Questions?

To summarize, each learning trial consists of two series of presentations: the first with both left- and right-hand members and the second with only the left hand member exposed. When the left hand member is shown, you will have 4 sec. in which to spell the letters of the right hand syllable which was previously paired with it. We will continue this procedure until you have given two completely correct trials in a row. Do you have any further questions?

POST-EXPERIMENTAL QUESTIONS

1. Did you find the colors to add to the ease of learning the first part of the experiment? How?
2. On the last part here with the cards, did you find the colors to be helpful or detrimental? How?
3. When the color was (added, taken away) during this interval, what did you think should happen in terms of speed of learning?
4. Were the colors paired with the same or different

syllable as compared to the first list?

5. Were the syllables themselves in any particular order on these cards as compared to the first list?

Appendix 2

Listing of the three serial lists (trigram and color combinations) used in serial learning. Also presented are the trigram association values.

I		II		III		Association Value
Yellow	YIM	White	QAR	Gray	NIQ	31
Black	WOX	Blue	DUY	Red	BOF	34
Orange	GAK	Tan	JOZ	Purple	LUH	31
Green	ZET	Pink	PIW	Brown	VEC	35
Gray	QAR	Yellow	NIQ	White	YIM	31
Red	DUY	Black	BOF	Blue	WOX	34
Purple	JOZ	Orange	LUH	Tan	GAK	31
Brown	PLW	Green	VEC	Pink	ZET	31
White	NIQ	Gray	YIM	Yellow	QAR	34
Blue	BOF	Red	WOX	Black	DUY	31
Tan	LUH	Purple	GAK	Orange	JOZ	34
Pink	VEC	Brown	ZET	Green	PIW	31
					Total	32.5

Listing of the nine paired-associate lists used during PA learning. Stimulus terms are either the preceding trigram and color (TC) or trigram (T) or color (C) to the response term.

I

TC		T		C	
Stimulus	Response	Stimulus	Response	Stimulus	Response
Yellow - YIM	WOX	YIM	WOX	Yellow	WOX
Orange - GAK	ZET	GAK	ZET	Orange	ZET
Gray - QAR	DUY	QAR	DUY	Gray	DUY
Purple - JOZ	PIW	JOZ	PIW	Purple	PIW
White - NIQ	BOF	NIQ	BOF	White	BOF
Tan - LUH	VEC	LUH	VEC	Tan	VEC

II

White - QAR	DUY	QAR	DUY	White	DUY
Tan - JOZ	PIW	JOZ	PIW	Tan	PIW
Yellow - NIQ	BOF	NIQ	BOF	Yellow	BOF
Orange - LUH	VEC	LUH	VEC	Orange	VEC
Gray - YIM	WOX	YIM	WOX	Gray	WOX
Purple - GAK	ZET	GAK	ZET	Purple	ZET

III

Gray - NIQ	BOF	NIQ	BOF	Gray	BOF
Purple - LUH	VEC	LUH	VEC	Purple	VEC
White - YIM	WOX	YIM	WOX	White	WOX
Tan - GAK	ZET	GAK	ZET	Tan	ZET
Yellow - QAR	DUY	QAR	DUY	Yellow	DUY
Orange - JOZ	PIW	JOZ	PIW	Orange	PIW

EXTRASERIAL CUES IN VERBAL LEARNING

by

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Studies in paired-associate (PA) learning have established that, given a compound stimulus term of discriminable components, the greater the discrepancy in ease of learning between these components, the more probable it is that the subject (S) will rely more heavily upon the easier of the elements as the cue for the elicitation of the response. Furthermore, there is evidence to suggest that added cues in learning are utilized during and following intermediate stages of learning as a means of combatting intralist interference.

Extraserial cues are those elements (e.g., colors) added to a serial list which do not comprise a requisite part of the S's responses. Moreover, such cues previously have been shown to develop stimulus properties in serial learning (SL). Specifically, earlier studies have indicated extraserial cues to be utilized to a greater extent in the more difficult middle than easier end positions of the list. However, the presence of these cues also apparently provides a source of interference for the S, whereby overall acquisition of the list is retarded.

It was hypothesized that if extraserial cues are ommitted until the easier items in the serial list are acquired, then acquisition of the more difficult middle positions would benefit the most from extraserial cues. In this manner, Ss are prevented from unnecessarily attending to extraserial cues at the outset of learning thus reducing stimulus competition between primary and extraserial elements of the list. Furthermore, if these cues serve to reduce interference late in learning as suggested by PA studies, then Ss who have these cues inserted late in learning should attain a performance criterion at a rate faster than Ss who have cues a) present throughout learning, b) present during early stages of learning but absent during later stages, and c) absent throughout learning.

To test the above predictions, four groups of 27 Ss first learned an identical serial list of 12 trigrams under each of the above experimental conditions. Extraserial cues were differently colored backgrounds pasted over the trigrams. After SL, each condition was divided into three matched subgroups of nine Ss for a PA learning transfer task. The six pairs to be learned all contained the even-numbered trigrams of the serial list as response terms. To assess sequential associations formed during SL, the stimulus terms differed for the three subgroups, being either a) a compound stimulus of both the immediately preceding odd-numbered trigram and color, b) the trigram alone, or c) the color alone. Three additional groups of 12 Ss learned each of the three PA transfer lists without prior SL.

The results provided no evidence that extraserial cues added late in learning benefit acquisition. Rather, such cues appear to be partially, if not wholly, ignored by the S for the remainder of SL. Nonetheless, color cues were shown to display stimulus properties given that they are present from the outset of learning. The extent of cue utilization, moreover, was found to vary with positional difficulty; the S seems to rely more heavily upon color as a stimulus in the middle than at the beginning or end of the serial list.