These remained on the screen for 10 sec, while S attempted to recall the trigram. A 10-sec intertrial rest interval followed before the start of the next trial.

RESULTS AND DISCUSSION

The data of each S were scored in terms of the number of consonants correctly recalled, regardless of whether they appeared in the correct intratrigram position. With low-association-value trigrams, it appears that the item score is the most meaningful and sensitive unit of analysis (Wickelgren, 1965). Results are not presented for ordered scores because in all important respects they are in close agreement with the item scores.

An overall analysis of variance indicated that the effects of presentation activity (voiced vs silently read), $F(1,59) = 65.55$, $p < .001$, retention interval, $F(5,295) = 132.38$, $p < .001$, and the Presentation Activity by Retention Interval interaction, $F(5,295) = 2.93$, $p < .05$, were all significant. As can be seen in Fig. 1, recall performance decreased over retention intervals for both presentation activities. Further, it can be seen that voiced presentation conditions were superior to silently read conditions at all retention intervals tested. It was hypothesized that vocalization activity would be a facilitating source of information as compared to silent reading, and this is supported by the significant main effect of presentation activity.

In order to determine if vocalization activity was more beneficial at the shorter retention intervals than at the longer ones, the data from the six retention intervals was dichotomized into shorter retention intervals (1, 3, and 5 digit pairs) and longer ones (8, 11, and 14 digit pairs). An analysis of variance was performed on these condensed data. The most relevant finding from this analysis was the highly significant Presentation Activity by Retention Interval interaction, $F(1,59) = 106.81$, $p < .001$. This interaction indicates that vocalization activity has its major influence at these shorter retention intervals and lends support to the second hypothesis. These findings also parallel those of Grant & McCormack (1970), who found that the type of presentation condition (auditory vs visual) had its major effect at the shorter retention intervals. The similarity of these findings may indicate that the variable of underlying importance is the auditory input which results from either auditory presentation or vocalization activity.

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Serial task structure and the doctrine of remote associations

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A series of studies by Slamecka (1964) provided impetus for developing three criteria to test the validity of anticipatory and perseverative errors. Since these criteria were met by conditions of a previous study (Ellis & Manning, 1967), supplementary data were collected, combined with the earlier data, and reexamined. In addition to finding support for Slamecka's concept of item positioning, it was determined that intraitem structure also affects frequency and distribution of serial learning errors. Comparing these results with expectancies predicted by remote association theory cast additional doubt on the validity of anticipatory and perseverative errors.

An examination of new data combined with data from a previously reported study (Ellis & Manning, 1967) is presented in this report. Although the original study did not include this objective, the author feels that when combined with the supplementary data, results of this new analysis justify presentation. The results are particularly relevant since they throw additional light on a classical concept of psychology, namely the doctrine of remote associations.

Briefly, this doctrine asserts that during serial learning, associative bonds develop between items other than adjacent items. When an association exists between a stimulus and an item which has occurred earlier in the sequence, it is called a perseverative error. A bond is called an anticipatory error if the stimulus is linked with an item which is further ahead in the sequence. Anticipatory errors are said to outnumber perseverative errors, and the frequency of each is inversely related to degree of remoteness.

Previous research generally supported these ideas until the report of a series of studies by Slamecka (1964). He concluded that the doctrine of remote associations was of doubtful validity, and he presented alternative explanations for data resulting from typical methods of study. He made a strong case for "perception of patterning" and "differential practice."

Slamecka's dismissal of anticipatory and perseverative errors, however, is not as convincing. In his discussion he rejects the assumption that intralist errors are remote associations. They are more likely, he says, the result of two things operating in the experimental task: (1) acquisition of items, per se, and (2) fixing of their position in the list using self-generated sequential or spatial symbols. The apparent difficulty is that Slamecka argues from data (Table 4, p. 72) that are identical to data of early theorists. It occurred to this author that a more substantive test was required before one could dismiss the validity of anticipatory and perseverative errors.

Criteria for such a test would include: (1) reducing the task of item acquisition, (2) relaxing the requirement for item positioning, and (3) retaining the serial nature of the task. It occurred to this author that these conditions had in fact been met in his earlier study. Criteria 2 and 3 were met by construction of a series of stimuli having a particular kind of underlying structure. This structure was used to define serial learning tasks in which the initial stimulus was varied from trial to

Table 1
Errors on Task 1: High Intraitem Similarity

Degree of Remoteness	Anticipatory Errors: Absolute Totals	Corrected Totals	Ordinal Value A	Ordinal Value E	Perseverative Errors: Absolute Totals	Corrected Totals	Ordinal Value A	Ordinal Value E
0	-	-	-	-	154	154	4	1
1	213	249	3	1	123	160	3	2
2	127	177	4	2	78	117	6	3
3	71	124	6	3	64	128	5	4
4	69	160	5	4	90	270	2	5
5	75	262	2	5	65	390	1	6
6	68	476	1	6	-	-	-	-
TOTAL	623	52%	$r_s = -.51$		574	48%	$r_s = -.48$	

trial without destroying the serial nature of the task. Criterion 1 was met by using the *method of complete presentation.*

An examination of the error data developing under these conditions, therefore, should provide some insight into what happens when serial positioning cues have been reduced. If Slamecka is correct, the resulting frequency and distribution of intralist errors will differ from previously obtained distributions of remote associations. On the other hand, if remote associations inherently develop in serial tasks, the frequency and distribution of anticipatory and perseverative errors should not change.

METHOD

The method, including stimuli, apparatus, and procedures, have been described in detail under Experiment II of the author's earlier study (Ellis & Manning, 1967). Briefly, the stimuli were dot patterns, and the structure underlying the stimulus items was physical similarity. Complexity of the stimuli prevented the Ss from detecting the existing structure. Only two of the previous study tasks are pertinent to this report: (1) Task I, made up of a fixed sequence of items having high intraitem similarity, and (2) Task II, made up of a fixed sequence with low intraitem similarity. The first stimulus of each sequence was the initial item on Trial 1; the second stimulus of the sequence was the initial item on Trial 2; the third stimulus was initial item of Trial 3; and so forth. Ss received 18 learning trials. To supplement the error data of this previous study, data were collected from 30 additional Ss comparable with the previous 30 Ss.

RESULTS AND DISCUSSION

Results are summarized in Tables 1 and 2. Errors are categorized under major headings of anticipatory and perseverative. Two columns under each heading contain absolute and corrected total number of errors as a function of degree of remoteness. The other column contains ordinal scale values, supplied by the author, representing actual frequency of errors obtained and expected frequency suggested by remote association theory. Total number of anticipatory and perseverative errors and corresponding percentages are shown at the bottom of each table.

Before examining these tables closely, one should recall that previous research has demonstrated that (1) anticipatory errors outnumber perseverative errors about 9 to 1 and (2) error frequency decreases with remoteness. The data summaries in Tables 1 and 2 do not support these previous findings. The chi-square value from a one-sample test comparing the obtained error frequencies with an expected 9:1 ratio for Task I is 4,656.2 ($p < .01$). For Task II, chi square is 5,573.2 ($p < .01$). In correlating the ordinal scales for actual frequency of error and expected frequency as a function of remoteness, further discrepancies are apparent. The rank correlation coefficients (r_s) derived from Table 1 for the anticipatory and perseverative conditions are −.51 and −.48, respectively. In Table 2, r_s for anticipatory conditions is −.26 and −.63 for perseverative conditions. The negative signs reveal that the relationship is opposite from the expected and precludes one-tail testing for significance.

Tables 1 or 2, taken individually, support Slamecka's position of explaining serial-learning errors in terms of serial-position cues. In both tasks serial-position cues were, for all practical purposes, removed, and the usual features associated with frequency and distribution of serial-learning errors did not occur. Support for his position is reduced, however, when one compares Tables 1 and 2. The r_s between the two anticipatory conditions is −.26. Again the direction is opposite from the expected and requires no further testing for significance. Between the perseverative conditions, r_s is .71 ($p > .05$). Although this latter value borders on significance, it must also be rejected. From Slamecka's viewpoint the distribution of errors for Task I should not be any different from that for Task II, since serial position cues were altered in both cases. These differences can probably be accounted for by differences in similarity structure (i.e., high for Task I and low for Task II).

The results appear to support two conclusions. First of all, Slamecka's viewpoint, that frequency and distribution of serial-learning errors result from positioning items in the list through use of self-generated sequential symbols, is probably correct. It does not, however, tell the complete story. Secondly, there is at least one other factor that can operate in serial-learning tasks and that can also affect frequency and distribution of errors. This factor is the structure underlying the items to be learned. These two conclusions cast additional doubt on the validity of the doctrine of remote association.

Table 2
Errors on Task 2: Low Intraitem Similarity

Degree of Remoteness	Anticipatory Errors: Absolute Totals	Corrected Totals	Ordinal Value A	Ordinal Value E	Perseverative Errors: Absolute Totals	Corrected Totals	Ordinal Value A	Ordinal Value E
0	-	-	-	-	142	142	6	1
1	133	155	6	1	206	247	3	2
2	209	293	3	2	120	180	4	3
3	198	346	1	3	81	162	5	4
4	97	226	5	4	94	282	1	5
5	94	329	2	5	44	264	2	6
6	38	266	4	6	-	-	-	-
TOTAL	769	52.8%	$r_s = -.26$		687	47.2%	$r_s = -.63$	

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