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PROACTIVE TRANSFER AND ACOUSTIC SIMILARITY IN SHORT-TERM PAIRED-ASSOCIATE LEARNING

By

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INTERFERENCE IN LONG-TERM MEMORY

Interference is the most prominent explanation of forgetting in verbal long-term memory (LTM). Interference theory generally holds that forgetting is due to the competition of associations learned during the retention interval rather than to the decay of memory traces. Proactive interference results when the competing associations are learned prior to the criterion associations, and retroactive interference results when the competing associations are learned after the criterion associations. Further explanation of retroactive inhibition (RI) and proactive inhibition (PI) in paired-associate (P-A) learning is found in the extinction hypothesis of interference theory. According to the hypothesis, interference is due to unlearning or extinction of first list or prior learned responses during the learning of second list associations. Barnes and Underwood (1959) gave support to the extinction hypothesis by demonstrating that as the number of trials on the second list increased there was an increase in second list associations and a corresponding decrease in first list associations. With the passage of time, spontaneous recovery of the extinguished first list items occurs, thus explaining the commonly observed increase over time in PI (more interference from the first list) and the decrease in RI (first list responses become more available).

There are at least three specific components that are transferred from one P-A task to another. The process of P-A learning involves two stages, i.e., a stage in which the responses to be recalled or recognized are learned, and a second stage in which the associations are formed between these responses and appropriate stimuli. Feldman and Underwood (1957) have demonstrated that in P-A learning, backward associations as well as forward associations are formed. Thus from the association stage there are forward associations and backward associations available for transfer, and response availability is transferrable from the response learning stage.

INTERFERENCE IN SHORT-TERM MEMORY

In 1959, Peterson and Peterson conducted a unique verbal learning experiment by attempting to study the retention of a single verbal unit over very short intervals. Each S was presented separately eight different three-digit syllables at each of six retention intervals ranging in length from 3 to 18 seconds. To prevent rehearsal, the Ss were given the neutral interpolated task of counting backward by threes or fours from a number presented at the beginning of each interval. Results indicated a loss of retention as a positive function of the length of the retention interval.

Hebb (1949) postulated a dual process theory of memory, with interference operating in LTM, and trace decay operating in memory over very short intervals. Since the retention intervals in the Peterson and Peterson study were filled with the neutral, non-interferring task of backward counting, the results supported such a decay theory and directly challenged the theory of interference as the source of forgetting in short term memory (STM).

Keppel and Underwood (1962), like most theorists, viewed STM and LTM as being on a continuum and therefore governed by the same principles. They thus doubted the conclusions drawn from the Peterson and Peterson results, and in a series of experiments demonstrated that for the first item presented in the Peterson and Peterson procedure, recall was equal for long and short retention intervals. They also demonstrated that PI was built up after only one prior item was presented and that this PI increased as the retention interval increased, just as it does in LTM.

Keppel and Underwood (1962) thus gave strong support to a unitary conception of memory with interference operating in both STM and LTM. Subsequent research (Wickens, Born, and Allen, 1963; Goggin, 1966; Carlson, 1968) has generally been based on the assumption that interference does affect short-term retention and has attempted to determine if interference in LTM and STM are governed by the same principles and affected by the same variables.

<u>Interference Due to Acoustic Similarity</u>

Acoustic similarity as a variable in short-term retention was first reported by Conrad (1962). In a serial learning experiment, sequences of six letters were presented visually for immediate recall. Noticing that errors appeared to be between letters that sounded alike, Conrad conducted a speech intelligibility study on the letters used in the first experiment and found a significant correlation between errors in recall and errors in auditory perception. Conrad and Hull (1964) presented visually series of letters that were either acoustically similar or acoustically dissimilar. Significantly more errors in recall were made on the series with acoustically similar items.

Baddeley and Dale (1966) with serial recall, and Bruce and Crowley (1969) with paired associates have demonstrated that acoustic similarity is not a variable in LTM. Baddeley and Dale (1966) have suggested that items in LTM are coded by meaning and items in STM are coded by an acoustic system.

Wickelgren (1965b) offers two theories as to how acoustically similar items might be confused. The pattern-of-firing theory holds that an item is represented as a pattern of several large sets of neurons, and similar items have similar firing patterns. The specific-neuron theory of coding holds that items are represented by the firing of a small number of specific neurons, and similar items have overlapping sets of neurons. The question of what specific part of the nervous system is involved is still unsettled. Both an auditory system and an articulatory system have been proposed, but Wickelgren (1969) reports that attempts to resolve this issue are inconclusive and that an "abstract verbal system" may be neither purely auditory or purely articulatory.

Interference in Short-Term Serial Learning

Interference has been consistantly shown in serial learning experiments in STM. Typically a series of letters or numbers is presented, followed by a second series, and then the Ss are asked to recall the first series. Wickens et. al. (1963) and Corman and Wickens (1968) have shown that when letter series are followed by letter series or numbers are followed by numbers (item similarity) more interference is obtained than if letter-number or number-letter combinations are used.

As discussed earlier, acoustic similarity has been shown to produce interference in short-term serial learning. Wickelgren (1965a) found that when Ss were asked to recall an eight-item list of numbers and letters, intrusions among letters and among numbers as well as intrusions between numbers and letters could be predicted by the acoustic similarity among these items. Following this line of research Wickelgren (1965b) presented four letters auditorily followed by eight letters and a recall test for the original four. The experimental variable was degree of acoustic similarity between test and interferring items. Results indicated the greater the acoustic similarity, the greater the amount of RI. Dale (1964) confirmed these findings, and concluded that "the principle of retroactive inhibition does apply to STM [p. 1408]."

Interference in Short-Term Paired-Associate Learning

Murdock (1961) conducted an experiment on the short-term retention of single P-A items. He presented a list of five pairs of words at a two second rate and then after a 15-second interval tested one of the pairs by presenting only the stimulus member of that pair. Both RI and PI were studied, the serial position of the critical pair determining whether the test was considered to be retroactive or proactive. Results indicated both RI and PI effects.

Baddeley and Dale (1966) followed the Murdock procedure, but introduced the variable of semantic similarity in order to demonstrate RI and PI. A list of three word pairs was presented once at a rate of 2 seconds per pair. Each experimental list consisted of one buffer pair and two critical pairs with semantically similar stimuli and different responses, i.e., the A-B,A'-D paradigm which is a negative transfer paradigm. When this paradigm was compared with the control A-B,C-D paradigm, no RI or PI effects were found.

Dale (1967) argued that the Murdock procedure for STM was not analogous to P-A procedures in LTM and suspected the disparity as being the reason for the lack of significant transfer with the A-B,A'-D paradigm in the Baddeley and Dale (1966) experiment. He therefore presented and tested two separate lists before testing the first list for RI, a procedure analogus to the study-test method of P-A learning in LTM. Lists consisted of three word pairs and were taken from the Baddeley and Dale (1966) experiment. Each pair was presented for 4 seconds, and retention intervals were 10 seconds. Again semantic similarity of responses was used in comparing the A-B,C-D and A-B,A'-D paradigm, but no RI was found.

In an attempt to determine if RI and PI relationships obtained for STM were the same as those found in LTM, Goggin (1966) employed the negative A-B,A-C transfer paradigm and the positive A-B,A-B' paradigm. Stimuli were CVC trigrams and responses were English words, with B and B' words being semantically similar. Goggin did not follow the Murdock procedure, but presented two lists, one immediately following the other. Each list contained two pairs, the experimental lists forming either the A-B,A-C or the A-B,A-B' paradigms. Control Ss were presented only A-B pairs. In comparing control and experimental conditions, Goggin found significant PI effects but no RI effects for the A-B,A-C paradigm. No significant transfer effects for the A-B,A-B' paradigm were found.

Carlson (1968) also objected to the procedures being used to study P-A learning in STM. He proposed that in the Murdock procedure RI could have differential influence when the serial position of the critical pair was varied. He therefore used the study-test method of P-A learning in order to investigate the nature of proaction in STM by studying the three basic transfer paradigms (A-B,C-D; A-B,C-B; A-B,A-C). Lists consisted of two pairs of middle association value trigrams, and each pair was presented at a two-second rate. Retention intervals were varied and filled with backward counting to prevent rehearsal. Results were not entirely consistent with predictions from LTM, i.e., of the three paradigms, retention on the test list of the positive transfer paradigm (A-B,C-B) was superior to the other transfer paradigms, but retention on the control A-B,C-D and the negative A-B,A-C paradigms did not differ.

Acoustic similarity of items has been shown to affect interference in serial learning in STM, and Bruce and Murdock (1968) attempted to determine its role in P-A learning. The Murdock procedure was again employed with words used as P-A items. Each list contained six pairs grouped into three sets, the pairs of each set having either acoustically non-similar stimuli (A-B, C-D) or acoustically similar stimuli (A-B,A'-D). If the first pair of a set were drawn as the test or "probe" item, the paradigm was considered to be retroactive, and if the second pair were tested, then the paradigm was considered to be proactive. As would have been predicted in LTM, the A-B,A'-D paradigm produced a significantly greater amount of PI than did the A-B,C-D paradigm.

Goggin (1966), Baddeley and Dale (1966), and Dale (1967) found no RI effects, and it would therefore appear that RI is either not operating in short-term P-A learning, or it is being obscured by the current research techniques. Semantic similarity does not appear to be a variable in P-A transfer in STM, since neither Goggin (1966), Baddeley and Dale (1966), nor Dale (1967) found its effect.

Proactive transfer is, however, a variable in short-term P-A learning (Goggin, 1966; Carlson, 1968; Bruce and Murdock, 1968), and according to Bruce and Murdock (1968) it is significantly affected by acoustic similarity. The purpose of the present thesis is to investigate basic proaction in the three transfer paradigms and to investigate the interaction between proactive transfer and the variable of acoustic similarity. This latter purpose will be accomplished by varying the acoustic similarity of the stimuli in the A-B,C-D and A-B,C-B paradigms and response similarity in the A-B,A-C paradigm. In light of the work of Carlson (1968) and Bruce and Murdock (1968), predictions are made from the "laws" specified by Osgood (1949). The A-B,C-B paradigm is expected to result in positive transfer while the A-B,A-C paradigm is expected to result in negative transfer. Since transfer is negligible in the A-B,C-D paradigm, it will be used as a control. Negative transfer is expected in the A-B,A'-D paradigm as compared to the A-B,C-D paradigm, while positive transfer is expected in the A-B,A'-B and the A-B,A-B' paradigms when compared respectively to the

A-B,C-B and the A-B,A-C paradigms. In order for the results to be better compared with predictions from LTM, the procedure used by Carlson (1968) and Dale (1967) will be employed.

METHOD

Design. The normal P-A procedure or the study-test method of presentation was used in the present experiment. Each S served in two conditions of the experiment, the Acoustically Non-Similar condition and the Acoustically Similar condition. Therefore Ss studied and then were tested on four separate lists, i.e., a transfer list and a test list with no acoustically similar items, and a transfer list and a test list with acoustically similar items. To balance out any interference and/or learning-to-learn effects, one half of the Ss served in the Non-Similar and then in the Similar condition, while the remaining Ss received these conditions in reverse order.

To determine the effect of the interaction of acoustic similarity and the three transfer paradigms, a 3 X 2 factorial design was employed, with the first factor being Paradigms (A-B,C-D; A-B,C-B; A-B,A-C) and the second factor Acoustic Similarity (Non-Similarity; Similarity). The number of correct responses on the test lists of the Similarity and Non-Similarity conditions constituted the basic data. The number of correct responses on the Non-Similarity test lists of each paradigm was considered as the measure of basic proactive transfer.

Lists. Words were used as P-A items and were taken from a population of 254 word pairs compiled by Bruce and Crowley (1969). All words in the population are monosyllabic and have a Thorndike-Lorge G frequency of greater than 1. Words are paired such that members of a specific pair differ by only one distinctive feature of the initial phoneme (a speech sound that functions as a unit in a particular language). The pairs are classified into 30 groups according to their initial phoneme.

All lists contained three word pairs, the short P-A lists being used in order not to exceed the 60-second interval considered by Dale (1964) to be the limit of STM. However, in order to lessen the possibility that the results would be specific to the three item lists, two groups of lists (two transfer and two test lists) were developed for each of the three paradigms under the two conditions of similarity. Each S received, however, only one group in the Non-Similarity condition and only one group in the Similarity condition. Therefore a S received either the first group of lists (Set 1) or the second group (Set 2) for his particular paradigm. The lists used in the experiment are presented in Table 1.

Insert Table 1 about here

Table 1

Paired-Associate Lists in Sets Classified by Transfer Paradigms and Acoustic Similarity

Condition	List	A-B,C-D Paradigm Set 1	A-B,C-D Paradigm Set 2	A-B,C-B Paradigm Set 1	A-B,C-B Paradigm Set 2	A-B,A-C Paradigm Set 1	A-B,A-C Paradigm Set 2
Acoustically Non-Similar Condition	Transfer	THAW-RISE	DREAD-PLOT	THAW-RISE	DREAD-PLOT	THAW-RISE	DREAD-PLOT
		TILE-YAWN	TORN-BUZZ	TILE-YAWN	TORN-BUZZ	TILE-YAWN	TORN-BUZZ
		FAULT-THEN	ROOK-GLEAN	FAULT-THEN	ROOK-GLEAN	FAULT-THEN	ROOK-GLEAN
	Test	JET-BOAST	VOTE-JEST	JET-RISE	VOTE-PLOT	THAW-BOAST	DREAD-JEST
		SEAL-DANK	THRILL-NAME	SEAL-YAWN	THRILL-BUZZ	TILE-FRILL	TORN-NAME
		BAKE-FRILL	SHY-VERSE	BAKE-THEN	SHY-GLEAN	FAULT-DANK	ROOK-VERSE

Condition	List	A-B,A'-D Paradigm Set 1	A-B,A'-D Paradigm Set 2	A-B,A'-B Paradigm Set 1	A-B,A'-B Paradigm Set 2	A-B,A-B' Paradigm Set 1	A-B,A-B' Paradigm Set 2
Acoustically Similar Condition	Transfer	DREAD-PLOT	THAW-RISE	DREAD-PLOT	THAW-RISE	DREAD-PLOT	THAW-RISE
		TORN-BUZZ	TILE-YAWN	TORN-BUZZ	TILE-YAWN	TORN-BUZZ	TILE-YAWN
		ROOK-GLEAN	FAULT-THEN	ROOK-GLEAN	FAULT-THEN	ROOK-GLEAN	FAULT-THEN
	Test	TREAD-JEST	THAW-RISE	TREAD-PLOT	THAW-RISE	DREAD-BLOT	THAW-WISE
		THORN-NAME	PILE-DANK	THORN-BUZZ	PILE-YAWN	TORN-DOES	TILE-LAWN
		LOOK-VERSE	VAULT-FRILL	LOOK-GLEAN	VAULT-THEN	ROOK-CLEAN	FAULT-WREN

From the 30 groups of word pairs, 24 were selected by the use of a table of random numbers. One pair was then randomly selected from each of these 24 groups. From each of these pairs one word was selected, and these single words were then randomly re-paired to form four three-pair lists. These four lists constituted the two sets of lists for the A-B,C-D paradigm under the Non-Similarity condition.

The Similarity condition of this paradigm may be characterized as A-B,A'-D, and the A-B lists developed for this condition for Ss receiving Set 1 in the Non-Similarity condition were made up of the A-B lists from Set 2 of the Non-Similarity condition (words these Ss had never seen). The A' words were the respective rhymes of the A words and were obtained by referring to Bruce's original listing of acoustically similar pairs. The D words for this Set were the D words in Set 2 on the Non-Similarity condition. Lists for Ss receiving Set 2 in the Non-Similarity condition were also developed in the above manner, A-B and D being taken from Set 1, and A' from Bruce's listing.

The A-B lists described above were used as A-B lists in the A-B,A-C and A-B,C-B paradigms and were used in the same manner as they were in the A-B,C-D paradigm, i.e., lists were switched from Set 1 to Set 2 and vice versa in the two conditions of similarity. For the

A-B,A-C paradigm in the Non-Similarity condition, C or response words were the response words from the two C-D lists of the previously described paradigm, and in the Similarity condition (A-B,A-B'), B' words were from Bruce's listing. In the A-B,C-B paradigm, the C words were stimulus words from the two original C-D lists, and in the Similarity condition of this paradigm (A-B,A'-B), A' words were again from Bruce.

Thus all conditions contained the same two A-B lists as transfer lists. Test lists were developed according to the particular paradigm under study, but the stimulus and response words were the same for all test lists where the paradigm permitted.

Subjects. The Ss were 60 students enrolled in undergraduate psychology courses at the University of Richmond. Participation in the experiment was part of course requirements.

Procedure. Twenty Ss were assigned to each of the three paradigms, and one half of the Ss in each of these groups received Set 1 lists and the remaining Ss received Set 2 lists. Order of presentation of the Similarity conditions was counterbalanced for each set in all paradigms.

Lists were presented on a memory drum manufactured by Psychological Instruments, Inc. Pairs were typed on the drum tape in upper case with stimulus and response members of a pair separated by a single dash. The Ss were allowed 3 seconds to study and pronounce each pair on study trials and 3 seconds to respond to each stimulus on test trials. Retention intervals were 9 seconds in length, and to preclude any possibility of rehearsal during these intervals, the Ss were required to count backwards by threes from a three-digit number that appeared on the drum tape at the beginning of each interval. Thus Ss studied the transfer list, counted backward during the 9-second interval, and were tested on the transfer list. A 9-second interval immediately followed, and Ss then studied the test list, counted backwards, and attempted to supply the correct response to test list stimuli. This constituted the sequence of events for both similarity conditions in which each S participated. Presentation of conditions of similarity was separated by a five minute interval.

The Ss were given detailed instructions in the experimental procedure (see Appendix A), being told that when they were presented paired words, they were to pronounce both words and learn each stimulus-response pair so that when presented the stimulus word alone they could give the appropriate response. The Ss were also given instructions in backward counting, and the sequence of events of the experiment were explained to them. The P-A learning procedure was then demonstrated by means of a three-pair list printed on a poster on the wall of the experimental room.

RESULTS

The initial learning ability of the three groups was compared by means of a single factor analysis of variance. The dependent variable for the analysis was the number of correct responses each S made on the test trial on the first transfer list that he received. In all analyses data from both sets of lists within each group were pooled, and the mean number of correct first list responses for the A-B,C-D; A-B,C-B; and A-B,A-C paradigms were, respectively, 1.95, 1.80, 1.75. The analysis of variance yielded a non-significant result, $F(2,57) = 1$, $p > .05$. The three groups were therefore considered to be of equal learning ability. Summary tables for all analyses are presented in Appendix B, and the mean number of correct responses for all lists classified by Paradigms, Acoustic Similarity, and Sets is presented in Table 2.

Insert Table 2 about here

Proactive transfer in the three basic paradigms was assessed by a single factor analysis of variance of the Non-Similarity test lists of each paradigm. The number of correct responses constituted the basic data, and the means for the A-B,C-D; A-B,C-B; and A-B,A-C

Table 2

Mean Correct Responses in Sets Classified by Transfer Paradigms and Acoustic Similarity

		A-B,C-D Paradigm		A-B,C-B Paradigm		A-B,A-C Paradigm	
		Set 1	Set 2	Set 1	Set 2	Set 1	Set 2
Acoustically Non-Similar Condition	Transfer	1.70	2.10	2.20	2.10	1.70	1.80
	Test	0.70	1.20	2.30	2.70	0.70	1.00
		A-B,A'-D Paradigm		A-B,A'-B Paradigm		A-B,A-B' Paradigm	
Acoustically Similar Condition	Transfer	1.70	1.40	2.00	1.20	1.90	1.70
	Test	1.10	1.00	2.40	2.20	2.00	2.00

paradigms were, respectively, 0.95, 2.50, 0.85. The analysis yielded a significant result, $F\ (2,57) = 31.70$, $p < .05$.

The Newman-Keuls procedure indicated that the mean correct responses for the A-B,C-B paradigm was significantly larger than the means of the A-B,C-D and A-B,A-C paradigms. These two latter paradigms were found not to be significantly different. (See Appendix B for details.)

Transfer in the A-B,C-D control paradigm appeared to be relatively large and negative in direction, mean correct responses on the A-B and C-D lists being, respectively, 1.95 and 0.95. This control paradigm is generally held to produce negligible transfer, and therefore a single factor analysis of variance was performed, and the analysis indicated a significant difference, $F\ (1,38) = 9.31$, $p < .05$.

The effect of acoustic similarity in short-term P-A learning was investigated by an analysis of variance of the 3 X 2 factorial design (Paradigms X Acoustic Similarity). Data were the number of correct responses on the test trials of the Non-Similarity and Similarity conditions. The mean number of correct responses classified by Paradigms and Acoustic Similarity is presented in Table 3, and the Analysis yielded a significant finding for the interaction between Paradigms and Acoustic Similarity, $F\ (2,57) = 3.27$, $p < .05$.

Insert Table 3 about here

For the analysis of variance of the simple effects (see Appendix B for details), Acoustic Similarity was investigated at each of the three levels of Paradigms, and the only significant effect found was for the A-B,A-C paradigm, $F\ (1,57) = 23.62$, $\underline{p} < .05$.

Table 3

Mean Correct Test List Responses

Classified by Transfer Paradigms and Acoustic Similarity

Transfer Paradigm	Acoustic Similarity	
	Non-Similar	Similar
A-B,C-D	.95	1.05
A-B,C-B	2.50	2.30
A-B,A-C	.85	2.00

DISCUSSION

Keppel and Underwood (1962) have proposed that PI is the major source of interference in STM, and current research on short-term P-A learning would tend to support this proposal (Goggin, 1966; Carlson, 1968; Bruce and Murdock, 1968). Acoustic similarity of items has been shown to be a variable that significantly affects interference in STM (Dale, 1964; Wickelgren, 1965a, 1965b; Bruce and Murdock, 1968). The present thesis was designed to investigate proaction in STM by means of the three basic transfer paradigms and to assess the effect of acoustic similarity on each of these paradigms.

The present results are interpreted in terms of the extinction hypothesis of interference theory discussed earlier. Garskof (1968) and Murdock (1962) report studies that lend support to such an interpretation. The Garskof experiment was a retroactive P-A study in which Ss were given either traditional P-A instructions or special mediating instructions which prompted the use of mnemonic devices. Three retention tests were employed: recognition-matching; modified free recall and free recall. The mediating instructions resulted in significantly more correct first list responses only with the recognition-matching task. These results were interpreted as supporting a two-phase process of learning since mediating instructions improved the retention of the stimulus-response association, but did not affect response learning, i.e., only when the responses were before the Ss with the mediating instructions were they able to perform better on the retention test.

Murdock (1962) presented a series of A-B pairs to Ss and tested one pair (retention intervals from 0 to 10 seconds) by presenting either A or B and asking the Ss to supply the missing member of the pair. No significant differences were found between recall of A and recall of B, thus indicating that both forward associations and backward associations are formed in STM.

The A-B,C-D paradigm is traditionally used as a control condition since there are no forward associations, backward associations, or response availability transferrable from the first list to the second. For forward associations to be transferred, stimuli on the two lists must be identical. Thus when stimuli on the second list are presented, the stimulus-response associations from the first list are elicited. For backward associations to be transferrable, responses must be identical, the second list responses eliciting the backward associations learned on the first list. Responses must be identical for response availability to be transferred from one list to another. With none of these components available, transfer in the A-B,C-D paradigm should be negligible. However in the present experiment, the A-B,C-D paradigm produced negative transfer when the A-B and C-D lists were compared. Carlson (1968) also found negative transfer in this paradigm.

McGovern (1964) identifies a possible source of negative transfer in the A-B,C-D paradigm. She contends that during the response learning phase there is a form of association learning in which stimuli are context stimuli, or stimuli from the experimental room, equipment, etc. Since contextual stimuli are the same for both lists and responses are unrelated in the A-B,C-D paradigm, a negative A-B,A-C transfer paradigm is created. Bilodeau and Schlosberg (1951) have shown that RI can be reduced if second list learning takes place in an experimental room different from the one in which the first list was learned, thus supporting McGovern's hypothesis.

For the A-B,C-B paradigm, forward associations are not available for transfer since stimuli on the first list are unrelated to those on the second list. Because the responses are identical, response availability transfers from the first list to the second, creating a positive effect. However. backward associations form a negative transfer paradigm where stimuli are the same and responses differ (B-A,B-C). The positive response availability component in the present experiment apparently exerted the stronger influence, producing the observed net positive transfer. However, this effect could be inflated when the A-B,C-D paradigm is used as a control.

First list or transfer list learning in the present experiment was restricted to one brief trial. Martin (1965) suggests that if response learning preceeds association formation and degree of first list learning is low, then learning might not proceed much beyond the response learning stage. Interference or facilitation due to transfer of associations would therefore be reduced. For the A-B,C-B paradigm in the present experiment, the interferring effects of backward associations would thus be lessened.

The A-B,A-C paradigm is a negative transfer paradigm and has been cited as the negative transfer component in the previously discussed paradigms. Forward associations cause interference in this paradigm through extinction. In learning A-C, the association of A to B must be extinguished or unlearned. With the passage of time spontaneous recovery of the extinguished associations occurs, decreasing RI and increasing PI. Contextual associations between first line responses and environmental stimuli, which are the same for both lists, must also be extinguished in the learning of the second list. Predictions of negative transfer, however, was not upheld in the present experiment when the A-B,A-C paradigm was compared with the A-B,C-D control. There apparently was negative transfer in this latter paradigm, and the negative effects of the A-B,A-C paradigm could therefore have been masked. Also, according to the Martin (1965) analysis, low first list learning could tend to reduce negative transfer in the A-B,A-C paradigm by reducing the strength of interferring forward associations.

Similarity of the stimulus members of the A-B,C-D paradigm results in the negative A-B,A'-D paradigm. Interference in this latter transfer paradigm can be explained by stimulus generalization, or the tendency of a response associated with one stimulus to occur when a stimulus similar to the original is presented. Thus when A' is presented, B is elicited, interferring with the learning and recall of D. Negative transfer in the present experiment was not found, however, when the A-B,A'-D paradigm was compared with the A-B,C-D paradigm. Negative transfer in the A-B,A'-D paradigm could have been masked by the negative effects in the A-B, C-D paradigm. However, negative transfer in the A-B,A'-D paradigm results from interference from the associative stage, and if Martin (1965) is correct about the effect of low first list learning, then the predicted negative tranfer in the present experiment could have been reduced.

Increasing stimulus similarity in the A-B,C-B paradigm produces the A-B,A'-B paradigm. Transfer is positive and is generally held to be greater than the transfer in the A-B,C-B paradigm. Response availability, a positive component, is transferrable from the first list to the second in both paradigms. With similar stimuli and identical responses in the A-B,A'-B paradigm, stimulus generalization produces a second positive transfer component. The A' stimulus has a tendency to elicit B, the correct second list response, because it was originally associated with A. Therefore learning and recall of the second list is facilitated. In the present experiment transfer produced in this paradigm did not exceed the positive transfer in the A-B,C-B paradigm. Martin (1965) would predict reduced positive transfer in the A-B,A'-B paradigm in the present experiment since first list learning consisted of only one trial.

The A-B,A-B' paradigm, produced by response similarity in the A-B,A-C paradigm, results in less negative transfer than the A-B,A-C paradigm. This prediction was upheld in the present experiment. Response generalization, or the tendency of a stimulus to evoke responses similar to the one with which it was originally paired, accounts for the positive element in the A-B,A-B' paradigm. The second list stimulus, A, evokes B' since it is similar to B, thus facilitating learning and recall of the second list.

Although acoustic similarity did not affect P-A transfer in exactly the manner predicted, the present experiment has demonstrated that acoustic similarity has a significant effect on the A-B,A-C paradigm. Thus with the data from Bruce and Murdock (1968) on the A-B,C-D paradigm, it can be concluded that in STM acoustic similarity affects

P-A learning as well as serial learning. The effect of acoustic similarity was analogous to the effect of semantic similarity in the A-B,A-C paradigm in the present experiment and in the Bruce and Murdock (1968) study, indicating that the two variables operate according to similar principles.

The results of the investigation of basic proactive transfer in STM are essentially in agreement with the results reported by Carlson (1968) and add to the generality of his findings. Thus proactive transfer in short-term P-A learning has been demonstrated. However, results were not entirely consistent with predictions made from LTM, and the low degree of first list learning in STM studies was suggested as a possible contributing variable. The actual locus of PI is not clear from the present data or that of Carlson (1968). The traditional A-B,C-D paradigm produced a negative effect which did not differ from the A-B,A-C negative transfer paradigm. Contextual associations were cited as a possible source of this negative effect. If meaning is not an important variable in STM, as Baddeley and Dale (1966) have suggested, then contextual associations may take on increased importance, and the A-B,C-D paradigm might have to be considered a negative or PI paradigm and not a control condition. Clearly, this issue will have to be resolved in future research.

SUMMARY

Proactive transfer in short-term memory (STM) was investigated by means of the three basic transfer paradigms, and the effect of acoustic similarity on each of these paradigms was assessed. Predictions of the direction of transfer and the effect of acoustic similarity were made from the principles of interference derived from experiments in long-term memory (LTM).

The 60 _Ss_ were assigned to one of the three transfer paradigms and served in both the Non-Similarity and Similarity conditions of that paradigm. The study-test method of paired-associate (P-A) learning was used, with _Ss_ studying and being tested on a transfer and test list with no acoustically similar items and a transfer and test list with acoustically similar items. The number of correct responses on the test lists of the Non-Similarity condition was considered as the measure of basic proactive transfer in the three paradigms. The effect of acoustic similarity was assessed by means of a 3 X _2_ factorial design with factors being Paradigms and Acoustic Similarity.

Results were not entirely consistent with predictions from LTM. Negative transfer was found ir the A-B,C-D control paradigm and contextual associations were cited as the possible negative transfer component. Negative transfer in the A-B,A-C paradigm was thought to have been masked by the negative effects in the A-B,C-D control paradigm. The A-B,C-B paradigm produced the predicted positive transfer, but this effect could have been inflated due to the A-B,C-D control. Acoustic similarity of responses on the A-B,A-C paradigm reversed the direction of transfer as predicted, but similarity of stimuli in the A-B,C-B paradigm did not increase positive transfer. Negative transfer produced by similarity of stimuli in the A-B,C-D paradigm was thought to have been masked by the negative transfer in the A-B,C-D paradigm. It was also suggested that negative transfer in the A-B, A'-D and A-B,A-C paradigms and positive transfer in the A-B,A'-B paradigm could have been reduced in the present experiment by the low degree of first list learning and the consequent low strength of first list associations.

The present research generally demonstrated proactive transfer in short-term P-A learning, and suggested that the locus of proactive inhibition might not be entirely confined to the A-B,A-C negative transfer paradigm since the traditional A-B,C-D control paradigm produced a negative transfer effect. The significant effect of acoustic similarity in the A-B,A-C paradigm demonstrated that acoustic similarity is a variable in proactive transfer in short-term P-A learning and suggested that acoustic similarity in STM and semantic similarity in LTM operate according to analogous principles.

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APPENDIX A

INSTRUCTIONS GIVEN TO SUBJECTS

You are participating in a verbal learning experiment studying memory over very short intervals. In the window of this memory drum you will be presented three types of items: single words; paired words; and numbers. The left hand member of the word pairs is the stimulus and the right hand member is the response. When presented the paired words, you are to pronounce both words and learn each stimulus-response pair so that when you are presented the stimulus word alone, you can give the appropriate response. Thus the single words that appear in the window will be stimulus words, and you are to give the particular response that has been paired (associated) with it. When you see a number in the window you are to count backwards by threes from that number until told to stop, e.g., if 27 were presented you would say "24, 21, 18, etc."

You will be presented in the following order:

(1) A learning trial with three stimulus-response pairs.

(2) A number from which you are to count backwards.

(3) A "test" trial in which only the stimulus

words appear and in which you attempt to supply the appropriate response term.

This sequence will be repeated several times. Be sure to pronounce aloud the word pairs when they are presented, but you do not have to pronounce the stimulus when it is presented alone on test trials. If you are not sure of the response, you may guess.

APPENDIX B

SUMMARY TABLES FOR STATISTICAL ANALYSES

Table 1

Analysis of Variance: First List Responses

Source	SS	df	MS	F
Between Methods	.44	2	.22	.24
Experimental Error	51.90	57	.91	
Total	52.34	59		

Table 2

Analysis of Variance:
Proaction in 3 Basic Paradigms

Source	SS	df	MS	F
Between Methods	34.23	2	17.12	31.70*
Experimental Error	30.50	57	.54	
Total	64.73	59		

*$p < .05$

Table 3

Newman-Keuls Test of Differences Between Ordered Means

(Three Basic Proactive Paradigms)

		A-B,A-C	A-B,C-D	A-B,C-B
		1	2	3
Ordered Means		.85	.95	2.50
K			2	3
$q_{.95}(K,57)$			2.84	3.41
$s_{\bar{x}}q_{.95}(K,57)$			.34	.56
Ordered Differences			2	3
	1		.10	1.65*
	2			1.55*

*$p < .05$

Table 4

Analysis of Variance

Transfer in the A-B,C-D Paradigm

Source	SS	df	MS	F
Between Methods	9.03	1	9.03	9.31*
Experimental Error	36.75	38	.97	
Total	45.78	39		

*$p < .05$

Table 5

Analysis of Variance:

Effect of Acoustic Similarity on Proactive Paradigms

Source	SS	df	MS	F
Between Subj.	99.49	59		
A (Paradigms)	47.62	2	23.81	26.16*
Subj. w. groups	51.87	57	.91	
Within Subj.	45.50	60		
B (Acoustic Similarity)	10.07	1	10.07	17.98*
AB	3.65	2	1.83	3.27*
B X Subj. w. groups	31.77	57	.56	

$*p < .05$

Table 6

Analysis of Variance:

Simple Interaction Effects of Acoustic Similarity and Paradigms

Source	SS	df	MS	F
Acou. Sim. at A-B,C-D	.10	1	.10	.18
Acou. Sim. at A-B,C-B	.40	1	.40	.71
Acou. Sim. at A-B,A-C	13.23	1	13.23	23.62*

*$p < .05$

Vita

Richard J. Pittman, the author, was born in Richmond, Virginia, June 8, 1945. He attended Henrico County public schools, graduating from Highland Springs High School in June, 1964. The following September, he entered Richmond College as a freshman, and in June, 1968, he was awarded the degree of Bachelor of Arts in psychology. In September, 1968, he entered the Graduate School of the University of Richmond and expects to be awarded the degree of Master of Arts in psychology in June, 1971.