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MEANINGFULNESS AND DEGREE OF FIRST-LIST LEARNING AS RELATED TO TRANSFER IN THE S_1-R_2 AND S_2-R_1 PARADIGMS: A COMPONENT PROCESS ANALYSIS

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DISSERTATION COMMITTEE

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Abstract

In deriving transfer predictions for paradigms involving similarity relationships between first- and second-list stimuli (S_1-S_2) and responses (R_1-R_2) Martin (1965) has defined specific component process variables which are assumed to interact with the secondary variables of meaningfulness (m) and degree of first-list learning (DOL_1). The present paper considers the application of a component process analysis to transfer paradigms involving similarity relationships between first-list stimuli and second-list responses (S_1-R_2) and between second-list stimuli and first-list responses (S_2-R_1). Procedurally, performance in the A-B, B-A; A-B, C-A, and A-B, B-C paradigms, relative to performance in the A-B, C-D nonspecific transfer control, was evaluated under conditions where extreme values of m and DOL_1 were factorially manipulated. The results indicated increasing positive transfer in the A-B, B-A paradigm with increasing DOL_1 for both high and low m conditions. Significant differences between m and DOL_1 conditions within the A-B, C-A and the A-B, B-C paradigms were interpreted as supporting the prediction that net transfer effects result from the contribution of specific component process variables whose relative strength is determined by the interaction of m and DOL_1 which can function to either mitigate or enhance transfer performance.

Meaningfulness and Degree of First-List Learning as Related to Transfer in the S_1-R_2 and S_2-R_1 Paradigms: A Component Process Analysis

Martin (1965) in deriving net transfer predictions for paradigms involving similarity relationships between first- and second-list stimuli (S_1-S_2) and responses (R_1-R_2) has defined three specific component process variables which result from first-list response learning and the acquisition of bidirectional associations between the first-list stimulus and response items. Each of these variables is further assumed to interact differentially with the secondary variables of meaningfulness (_m_) and degree of first-list learning (DOL_1) in determining the relative contribution from the specific component process to transfer.

The conceptualization of S_1-S_2 and R_1-R_2 transfer in terms of specific component process has provided a theoretical model which functions to both explain and predict empirical data. Perhaps more importantly Martin has developed a theoretical orientation from which often discrepant results reported in the transfer literature can be integrated (Martin, 1965: Postman, 1971).

The present paper considers the application of a component process analysis to transfer paradigms involving similarity relationships between first-list stimuli and second-list responses (S_1-R_2) and between second-list stimuli and first-list responses (S_2-R_1). Thus conceived the four basic transfer paradigms generated are: A-B, B-A; A-B, C-A; A-B, B-C; and the nonspecific transfer control A-B, C-D (hereafter referred to as paradigms B-A, C-A, B-C and C-D respectively).

Houston (1964) has proposed a net transfer surface for these S_1-R_2 and S_2-R_1 paradigmatic relationships which offers four general predictions: (1) if the first-list responses are neutral with respect to second-list stimuli, then regardless of the degree of S_1-R_2 similarity transfer will be minimal, (2) if second-list responses are neutral with respect to first-list stimuli then as S_2-R_1 similarity increases negative transfer will increase, (3) if first-list stimuli are identical to second-list responses, then as S_2-R_1 similarity increases positive transfer will increase and, (4) if second-list stimuli are identical to first-list responses then increasing S_1-R_2 similarity will result in an initial decrease in negative transfer and a subsequent increase in positive transfer, as the similarity between S_1 and R_2 approaches identity. This net transfer surface then predicts maximal positive transfer for the B-A paradigm, maximal negative transfer for the B-C paradigm and zero transfer for the paradigms, C-A and C-D.

Houston (1966a) has reported data which support these net transfer predictions. A component process analysis, however, would suggest that net transfer effects result from an interaction between the particular paradigm involved and the secondary variables m and DOL_1 which can function to either mitigate or exaggerate transfer effects predicted from a net transfer surface. This conceptualization has been strongly supported in data obtained using the traditional S_1-S_2 and R_1-R_2 similarity paradigms (Postman, 1971) and would seem to offer a potentially fruitful approach to the investigation of transfer effects in the S_1-R_2 and S_2-R_1 paradigms.

Component Processes Defined

As previously mentioned Martin (1965) has assumed that the three component process variables defined in terms of first-list response and bidirectional associative learning, are sufficient to account for net transfer effects in the S_1-S_2 and R_1-R_2 paradigms. In extending such an analysis to the S_1-R_2 and S_2-R_1 paradigms, however, the contribution of first-list stimulus differentiation to transfer must be considered since in the C-A paradigm the first-list stimuli function as second-list responses and would be expected to affect net transfer in a manner similar to that encountered when considering response learning effects in the traditional C-B paradigm. With this addition the delineation of four component process variables relevant to the S_1-R_2 and S_2-R_1 paradigms is achieved: (1) the effect of first-list stimulus differentiation on second-list response learning, labeled here as the St component, (2) the effect of first-list response learning on second-list stimulus differentiation, the R component, (3) the effect of first-list forward associative learning on second-list acquisition, the F component, and (4) the effect of first-list backward associative learning on second-list acquisition, the B component.

Rather than simply describing net transfer effects Martin (1965) argues that an accurate conceptualization of transfer must incorporate separate surfaces for each component process, thus defining how a particular effect is transferred as a function of its position within the coordinate system of a particular surface. In line with this reasoning four separate transfer surfaces, one for each of the defined components St, R, F and B are presented in Figures 1 and 2.

Insert Figures 1 and 2 about here

Within the coordinate system for the St surface it can be seen that the effect of first-list stimulus differentiation on second-list response learning is solely positive and maximal when S_1-R_2 similarity is constant at identity, regardless of the relationship between S_2 and R_1 (B-A and C-A paradigms). As the similarity between S_1 and R_2 decreases from identity, the amount of positive transfer would be expected to decrease to a zero point where S_1 is neutral with respect to R_2 (B-C and C-D paradigms). Notice also that with S_1-R_2 similarity constant at neutrality, variations in S_2-R_1 similarity do not affect the prediction of zero transfer from the St component.

Regarding the effect of first-list response learning on second-list stimulus differentiation it is observed from the R surface that transfer again is predicted to be solely positive and maximal when S_2-R_1 similarity is constant at identity (B-A and B-C paradigms). With S_2-R_1 identity, variations in S_1-R_2 similarity do not affect the prediction of maximal positive transfer; however, as the similarity between S_2 and R_1 decreases the predicted amount of positive transfer also decreases to a zero point where S_2 is neutral with respect to R_1 (C-A and C-D paradigms). Also, the prediction of zero transfer from the R component is not affected by variations in S_1-R_2 similarity when S_2-R_1 neutrality is constant.

The F surface describes the predicted effect of first-list forward associative learning on second-list acquisition. It can be seen that this F effect is maximally positive with S_1-R_2 and S_2-R_1 identity (B-A). Decreases in the similarity between S_1 and R_2, with

S_2-R_1 identity (i.e., as B-A varies toward B-C), results in the prediction of decreasing positive transfer. This F surface also describes a maximal negative contribution with S_2-R_1 neutrality and S_1-R_2 identity (C-A). This negative function is predicted to decrease as the similarity between S_1 and R_2 decreases (i.e., as C-A varies toward C-D). If on the other hand S_1 is held identical to R_2 and S_2-R_1 similarity is varied a decreasing positive function followed by an increasing negative function is observed as S_2 and R_1 become more dissimilar (i.e., as B-A varies toward C-A).

The B surface describes the predicted effect of first-list backward associative learning on second-list acquisition. This component is predicted to produce a maximal positive contribution with S_1-R_2 and S_2-R_1 identity (B-A). With S_1-R_2 identity, a decreasing positive function results from the decreasing similarity between S_2 and R_1 (i.e., as B-A varies toward C-A). On the other hand with S_2-R_1 identity and S_1 neutral with respect to R_2 (B-C), maximal negative transfer is predicted, which decreases toward zero as S_2 and R_1 become more dissimilar (i.e., as B-C varies toward C-D). Holding S_2-R_1 similarity constant at identity describes an initial decreasing positive function and a subsequent increasing negative function as the similarity between S_1 and R_2 varies from identity (B-A) to neutrality (B-C).

As previously mentioned the analysis of net transfer effects, which result from the contribution of the four component process variables, is achieved by defining each particular paradigm in terms of its position within the coordinate system of each transfer surface. Such an analysis thus leads to specific predictions regarding paradigmatic transfer.

Paradigm Predictions

B-A Transfer. In the B-A paradigm the first-list stimulus and response items simply reverse their respective item functions. Regarding the position of B-A within the coordinate system of each surface it is observed that stimulus differentiation during first-list practice should facilitate the acquisition of second-list responses, relative to conditions where no relationship exists between S_1 and R_2 (e.g., B-C and C-D). In a like manner response learning during first-list practice should contribute positively to second-list stimulus differentiation particularly in those situations where second-list inter-stimulus similarity is high, since C-D Ss must differentiate new stimuli.

The acquisition of forward A-B associations during first-list practice should also make a positive contribution in the B-A paradigm since these associations are relevant for second-list acquisition. In a like manner the learning of backward B-A associations during first-list practice facilitates second-list performance since A is the appropriate response item in the second list. Notice that if associative learning is completed during first-list acquisition then second-list associative learning is complete prior to transfer. Thus the four component processes relevant to the B-A paradigm combine to produce maximal positive transfer.

C-A Transfer. In the C-A paradigm new stimulus items are used and the old first-list stimuli function as the second-list responses. With new second-list stimuli the R and B component processes do not contribute to the net transfer effect, only the St and F components are involved. The differentiation of first-list stimuli should function to facilitate second-list response learning and be most potent in those situations where C-D Ss must learn new and difficult response items. From the F component, first list forward associations should produce backward associative interference during second-list acquisition, with A eliciting B in competition with the new stimulus term C.

The C-A paradigm in Houston's transfer surface is viewed as being similar to the traditional C-B paradigm since zero net transfer is predicted. However, it would seem obvious from an application of Martin's component analysis that the viability of this prediction is dependent on the interaction of secondary variables. In the C-B paradigm for example transfer effects have been observed to vary from positive to negative, relative to C-D, as a function of the relative contributions of response learning and associative interference. Typically, the use of low m material or low degree of DOL_1 enhance the relative contribution of the response learning component, resulting in positive transfer (Dean and Kausler, 1962; Jung, 1963). High m material or extended first-list pratice, however, maximizes associative interference thus producing negative transfer (Dean and Kausler, 1964; Jung, 1963; Merkile and Battig, 1963; Postman, 1971). In the C-A paradigm the use of low m material would be expected to enhance the first-list positive transfer value of stimulus differentiation for second-list response learning, concurrently minimizing the F contribution and resulting in a net positive effect relative to a C-D condition where new response items must be learned. In a like manner those variables which enhance first-list associative learning, e.g., high m material or high degree of DOL_1, and minimize the St component would be expected to produce a net negative transfer effect relative to conditions where backward associative interference is not involved.

B-C Transfer. In the B-C paradigm new response items are paired with the old first-list responses which function as second-list stimuli. In this paradigm the St and F components do not contribute to the net transfer effect since new second-list responses are employed. A positive contribution, however, from first list response learning is predicted, and should be most potent in those situations where C-D Ss must differentiate new and difficult second-list stimuli. In this paradigm first-list backward associative learning would be expected to interfere with the acquisition of B-C associations during transfer since B elicits A in competition with the new C items.

In Houston's transfer surface B-C is viewed as being similar to the traditional A-C paradigm in producing net transfer effects which are always negative relative to C-D. Houston has assumed that in the B-C paradigm, like the A-C paradigm, associative interference effects are expected to be the major contributor in transfer. However, in the A-C paradigm, negative transfer effects have been observed to increase or decrease as the degree of first list practice increases (Jung, 1962; Mandler and Heinemann, 1956; Merikle and Battig, 1963; Postman, 1962). The role of first-list stimulus differentiation contributing as a positive component to second-list learning has also been found to produce varying transfer effects as a function of the degree of interstimulus similarity (Kennelly, 1970; Underwood and Ekstrand, 1968; Underwood and Freund, 1968).

For the B-C paradigm the relative contribution of the component processes R and B would also be expected to interact with relative secondary variables. For example, the use of high m material or extended first-list practice would be expected to both minimize the R component and maximize the B component producing a net negative transfer effect relative to a B-C condition where first-list associative learning has been minimized with abbreviated first-list practice or with second-list sitmuli which are difficult to differentiate.

As noted, much of the transfer literature suggests that stimulus differentiation may be only a minor component in paired associate acquisition (Martin, 1965; Postman, 1971). For this reason the R contribution in the B-C paradigm might be expected to be weak relative to the strong effect of associative interference. This being the case the interaction of secondary variables would produce only varying amounts of negative transfer. However, in the absence of much needed empirical data the present model incorporates the assumption that the R and B components, interacting with secondary variables, can produce either a positive or negative net transfer effect. It should also be pointed out that paired-associate acquisition using the anticipation procedure would be expected to result in unequal item availability (Asch and Ebenholtz, 1962: Kanak and Neuner, 1970), thus enhancing the contribution to second-list stimulus differentiation in the B-C and B-A paradigms, as compared to the traditional A-C and A-B paradigms, since these stimuli function as first-list response items and are being transferred from a recall rather than a recognition task.

A Net Transfer Surface

The component process model of S_1-R_2 and S_2-R_1 transfer suggests that predictions regarding net transfer effects within a particular paradigm will vary as a function of the influence of m and DOL_1.

More specifically the present model assumes that the strength of each component process relevant to a particular paradigm is determined by the secondary variables manipulated and that net transfer effects can be either positive or negative as a function of the relative contribution from each of these component processes. From the foregoing analysis a net transfer surface for the S_1-R_2 and S_2-R_1 paradigms can be generated. Such a surface is depicted in Figure 3. This surface presents the max-

Insert Figure 3 about here

imum positive and negative net transfer effects possible in the B-A, C-A, B-C and C-D paradigms predicted from a component process model.

It is interesting to note from this net transfer surface that relative to the C-A and B-C paradigms positive transfer is predicted in the B-A paradigm regardless of the secondary variable manipulations involved. The reason for this is that increased contributions from any one of the four transfer components is always positive (see Figures 1 and 2). For the C-A and B-C paradigms on the other hand net transfer effects are predicted to vary from positive to negative as a function of the relative position within the coordinate system of each component process variable, the relative position being determined by the secondary variables manipulated. More specifically the use of low m materials would be expected to enhance the contribution from the St and R component process variables. In a like manner low degrees of DOL_1 would enhance the St and R contributions to net transfer since both stimulus differentiation and response learning would be assumed to precede and overlap first-list associative learning in the paired-associate task (Martin, 1965; Underwood and Schulz, 1960). Negative transfer predictions for the C-A and B-C paradigms result when _m_ and DOL_1 function to enhance the contribution from either the F or B component process variables. Specifically the use of high _m_ materials or high DOL_1 would be expected to facilitate the development of first-list associations resulting in associative interference during transfer and thus negative transfer relative to the nonspecific transfer control condition.

Empirical Evidence

Several of the net transfer predictions are supported from the existing literature. In the B-A paradigm transfer performance relative to performance in the C-D condition has been observed to be solely positive in three experiments (Houston, 1966a; 1966b; and Murdock, 1956). Both of the Houston experiments employed high _m_ materials with an intermediate level of DOL_1 (using six first-list practice trials the correct response means varied from 31.03 to 39.00) and replicated the results of an earlier experiment reported by Murdock (1956) who compared B-A and A-B transfer performance using high _m_ CVCs and a one perfect first-list criterion. Further, Murdock's results indicated a nonsignificant difference between the A-B and B-A paradigms, both being superior to C-D. These results are expected from a component process conception of transfer since the use of high _m_ materials with intermediate values of DOL_1 would enhance the development of both the F and B component variables, thus facilitating second-list acquisition.

Transfer performance in the C-A paradigm has been found to vary from negative (Goulet and Barclay, 1965; Houston, 1966a; Murdock, 1958; and Schulman, 1967c) to zero (Schulman, 1967a, 1967b) to positive (Homzie, Weimer, Schwartz and Waters, 1969) as a function of specific interactions with secondary variables. In all four of the studies reporting negative transfer for the C-A paradigm either intermediate or high levels of DOL_1 were employed. In addition three of the four involved the use of high m materials. The exception was the Goulet and Barclay (1965) experiment where infrequently printed English words were utilized; however, first-list learning was carried to a criterion of three perfect trials. Houston (1966a) reported zero transfer in the C-A paradigm relative to the C-D on the first second-list trial; however, in terms of total second-list correct responses the reported means were 35.38, 28.75 and 27.5 for the paradigms C-D, C-A and B-C respectively. These data would suggest that negative transfer in the C-A paradigm results from associative interference produced by the use of high m materials and/or a high degree of DOL_1, i.e., conditions which enhance the contribution from the F as opposed to the St component process variable.

In both the experiments reporting zero transfer in the C-A paradigm (Schulman, 1967a; 1967b) the degree of first-list learning was low. Schulman (1967a) used the criteria of either 1/10 or 5/10 correct while Schulman (1967b) used a 3/7 correct criterion. In addition the materials used were of intermediate m value. Schulman (1967a) used midrange CVC stimuli and Schulman (1967b) used midrange CVC stimuli and responses. These data would suggest then that relative to conditions involving high m or high DOL_1 the contribution from the St component to transfer is enhanced when lower m materials or low degrees of DOL_1 are involved. Additionally the Schulman (1967b) experiment reported a trend toward positive transfer in the C-A paradigm, a result which is also supported from data obtained by Homzie et. al.,(1969). In this experiment positive transfer was observed for both the C-A and C-B paradigms under conditions of high intralist response similarity in the transfer list and with a first-list criterion of one perfect trial plus one additional practice trial. These authors concluded that the contribution from first-list stimulus differentiation in the C-A paradigm is similar in effect to that observed from first-list response learning in the C-B paradigm, producing greater positive transfer with highly similar first-list stimulus (i.e., for C-A) or response (i.e., for C-B) items.

Harcum (1953) has reported data for the C-A paradigm which are discrepant with the foregoing predictions derived from a component process model. Using a first-list criterion of two perfect trials and CVC materials (the m value for these materials was not reported) performance in the C-A paradigm was reported to be equivalent to that observed in the C-D control condition. It is possible, however, that extremely low m CVC materials, if used, could have functioned to enhance the contribution from the St component process variable to transfer under these DOL_1 conditions.

In the B-C paradigm transfer has been observed to vary from negative (Goulet and Barclay, 1965; Harcum, 1953; Houston, 1966a; 1966b; and Murdock, 1958) to zero (Schulman, 1967b). The Schulman (1967b) result is predicted from a component process conception of transfer since the use of low DOL_1 (3/7 correct) and intermediate m materials would be expected to enhance the contribution from first-list response learning to second-list stimulus differentiation (the R component) and minimize the associative interference component.

From the studies reporting negative transfer in the B-C paradigm it is observed that both the Houston (1966a; 1966b) and the Murdock (1958) experiments used high m materials with intermediate and high levels of first-list practice respectively. As mentioned the Goulet and Barclay experiment combined the use of low m materials with a stringent first-list criterion of three perfect trials. While Harcum (1953) did not report the m level of the CVC materials employed, practice was carried to a first-list criterion of two perfect trials. Collectively these data would suggest that under conditions of either high m and intermediate or high DOL_1, first-list associative learning is facilitated and the contribution from the B component is thus enhanced with the resulting prediction of negative transfer.

While the available data for the C-A, B-C and B-A paradigms are supportive of a component process conception of transfer they are by no means definitive. The model in its present stage of formulation can at best offer only ordinal predictions regarding the direction and degree of transfer within a particular paradigm. In addition comparisons between experiments is both difficult and of tenuous value to the development of a theoretical model. This results from a lack of specificity or even a consensus of opinion regarding the operational definition of secondary variables relevant to paradigmatic transfer. The use of the dichotomous labels of high and low for the secondary variables of m and DOL_1 can be quite misleading when comparisons between experiments are involved. This is particularly true given the relativistic nature of the predictions derived from a component process model of transfer.

The purpose of the present experiment was to evaluate the relative contributions from the St, R, F and B components in the C-A, B-C and B-A paradigms, relative to C-D, under conditions where extreme values of m and DOL_1 are factorially manipulated. In this manner more adequate comparisons both within and between paradigm conditions, defined in terms of different or identical levels of m and DOL_1, can be accomplished in the same experiment. In addition the experiment was designed to evaluate transfer performance under several paradigm conditions where empirical data are not available in an attempt to further validate the component process model prediction of an interactive relationship between the particular paradigm involved and the secondary variables of m and DOL_1.

Method

Subjects. The Ss were 288 undergraduates enrolled in freshman and sophomore Psychology classes at Central State University. All Ss were volunteers and naive to the paired-associate learning task. There were 12 Ss in each of 24 experimental treatment conditions. The Ss were assigned to conditions in blocks of 24, with one S from each condition per block. The running order within each block was determined by a random numbers table and the order in which Ss appeared at the laboratory. A total of 29 Ss were replaced in the experiment after failing to learn either the first- or second-list. All of these Ss came from treatment conditions involving low m materials with 6, 8, 9 and 6 Ss for each of the paradigms C-D, C-A B-C and B-A respectively.

Experimental Design and Materials. The effects of two levels of m and three levels of DOL_1 on transfer performance were investigated in the C-D, C-A, B-C and B-A paradigms. The combination of these three variables produced a 2 x 3 x 4 completely randomized factorial design with 12 Ss per treatment condition. All Ss were required to learn two lists with the paradigm manipulation occurring in the first-list.

The six pair CVC lists were constructed using two levels of m, either low or high, defined by Archer (1960) in terms of association value as (0-20%) and (93-100%) respectively. The three degrees of first-list learning either low, intermediate, or high were defined in terms of the first-list criteria of 3/6 correct in a single trial, 6/6 correct in a single trial, or 6/6 + 50% additional learning.

The paradigm lists presented in Appendix D were constructed from two different item pools, with the appropriate restrictions on m, to increase generality of the results. In addition the stimulus and response item functions for each of the paradigm lists were counterbalanced. Thus, a total of 40 different lists were constructed with 32 different first-task lists and eight different second-task lists. Intralist formal similarity, defined in terms of letter and letter position duplications, was minimized for the low m CVC materials. The total number of intralist letter duplications varied between lists from 17-20. In addition no single consonant or vowel appeared more than three times in the same position and not more than four times within a list. Each list was also constructed such that the initial letter in a given stimulus item was not duplicated in the initial position for the remaining stimuli in the list. Since the stimulus and response item functions were counterbalanced this restriction also applied to the responses within a particular list. In constructing lists composed of high m materials (CVC words) the above restrictions were followed as nearly as possible with the additional requirement that no obvious associative relationship between stimulus and response items occurred.

Procedure. All lists were typed in capital letters and presented in four different random orders, to minimize serial position effects, on a Lafayette Memory Drum at a 2:2 sec rate, with a 4 sec intertrial interval. Each S was tested individually after receiving standard paired-associate instructions for the anticipation method. In addition each S was given four practice trials on a three pair list composed of CVC materials at the appropriate m value to insure familiarity with the experimental procedure. The Ss in both the high and low m conditions were required to spell the response during the anticipation interval, a correct response being scored only if all three letters were given in the appropriate order.

Following an initial study trial first-list practice continued until the appropriate criterion of either 3/6 correct, 6/6 correct or 6/6 + 50% additional learning had been reached. To achieve 50% additional learning practice was continued past the first perfect trial for half again as many trials as had been required to reach criterion. If criterion performance was accomplished on an odd numbered trial an additional trial was simply added to this total and practice continued for the appropriate number of trials. In the 3/6 correct condition practice continued until at least three correct responses were given in a single trial.

Approximately 30 sec. after completion of first-list practice each S was transferred to the appropriate second-list. For second-list learning Ss were informed that they should follow the same instructions and that practice would continue until no errors were made. The reason for this was that Ss who received a first-list criterion of 3/6 correct could conceivably have developed an inappropriate "set" regarding the requirements of the second-list. The first second-list trial was a guessing trial; however, the Ss were not instructed regarding the relationships between the lists. Practice on the second-list continued until a criterion of 6/6 correct in a single trial was achieved.

Results

First-List Learning

Since different first-lists were used in each of the transfer conditions there exists the possibility of variations in list difficulty between conditions. For this reason separate analyses of variance were used to compare performance on each of the first-list criteria.

Using trials required to achieve a first-list criterion of 3/6 correct anticipations all 24 treatment conditions were compared in a 2 x 3 x 4 factorial analysis of variance. Only the main effect for m achieved significance $F(1,264)=204.57$, $p<.0001$. The main effect F-ratios for the dummy variables of DOL_1 and transfer paradigm and for each of the possible interactions were nonsignificant (all $ps>.10$). In the high m conditions the overall mean was 5.95 and the range of means for the 12 groups was 4.83 to 7.67. In the low *m* conditions the overall mean was 15.66 with a range of means from 13.50 to 17.92.

The *S*s receiving either intermediate or high DOL_1 were compared in a 2 x 2 x 4 factorial analysis of variance using a first-list criterion of one perfect trial (6/6 correct anticipations). Again only the main effect for *m* achieved significance $F(1,176)=197.02$, $p<.0001$. The remaining main effects and interaction F-ratios were nonsignificant (all *p*s$>.10$). In the high *m* conditions the overall mean was 17.02 and the range of means for the eight groups was 14.42 to 20.25. In the low *m* conditions the overall mean was 39.99 with a range of means from 35.67 to 47.00. Similar results were obtained using total errors as a response measure and the first-list criteria of 3/6, 6/6 and 6/6 + 50%. In each analysis only the main effect for *m* achieved significance ($p<.0001$).

Second-List Acquisition

Trials to Criterion. The second-list criterion for all treatment conditions was 6/6 correct anticipations in a single trial. A 2 (low vs high *m*) x 3 (low, intermediate or high DOL_1) x 4 (B-A, C-A, B-C or C-D) completely randomized factorial analysis of variance was performed on both total errors and the trials to criterion response measure for second-list acquisition. The trials to criterion analysis revealed significant main effect F-ratios for *m*, $F(1,264)=494.70$, $p<.0001$; DOL_1 $F(2,264)=3.91$, $p<.025$; and paradigm, $F(3,264)=5.71$, $p<.001$. In addition the analysis revealed significant interactions for *m* x paradigm, $F(3,264)=5.81$, $p<.001$; and for DOL_1 x paradigm, $F(6,264)=4.14$, $p<.01$. Nonsignificant *m* x DOL_1 ($p>.05$) and *m* x DOL_1 x paradigm ($p>.10$) interactions were obtained. The trials to criterion means and standard deviations are presented in Table 1.

Insert Table 1 about here

Total Errors. The errors analysis revealed significant main effect F-ratios for m, $F(1,264)=469.18$, $p<.0001$; DOL_1, $F(2,264)=7.31$, $p<.001$; and paradigm, $F(3,264)=19.28$, $p<.001$. In addition the analysis revealed significant interactions for m x DOL_1, $F(2,264)=4.73$, $p<.01$; m x paradigm, $F(3,264)=5.86$, $p<.001$; and DOL_1 x paradigm, $F(6,264)=3.02$, $p<.01$. The three way interaction, m x DOL_1 x paradigm, was nonsignificant ($p>.10$). The means and standard deviations for total errors are presented in Table 2.

Insert Table 2 about here

Percentage of Transfer. The analysis of first-list learning revealed differences in list difficulty as a function of high or low levels of m. In addition extreme heterogeneity of variance was observed. The range in standard deviations was from 2.53 to 15.12 and from 5.31 to 61.99 for trials to criterion and total errors respectively. For these reasons the data were transformed to a percentage of transfer measure recommended by Read and Scarlett (1973) using the formula $100 \times (\bar{C}-E)/(\bar{C}+E)$, where the mean number of second-list total errors for the appropriate C-D condition was used as the control group ($\bar{C}$) value. Relative to both the trials to criterion and total error analyses this transformation had the advantage of making the data more homogeneous (the standard deviations ranged from 10.28 to 27.89) and permitted comparisons across levels of m which were independent of list difficulty effects. The mean percentage of transfer relative to C-D (zero transfer) computed from group means for each of the high and low m paradigm conditions across levels of DOL_1 are represented in Figure 4.

Insert Figure 4 about here

The transformation to a percentage of transfer response measure permitted a 2 (high or low m) x 3 (low, intermediate or high DOL_1) x 3 (B-A, C-A or B-C) completely randomized factorial analysis or variance. This analysis revealed significant main effect F-ratios for DOL_1, $F(2,198) = 5.22$, $p < .01$; and for paradigm, $F(2,198) = 51.93$, $p < .0001$. The main effect F-ratio for m was nonsignificant ($p > .10$). In addition the analysis revealed significant interactions for m x paradigm, $F(2,198) = 3.17$, $p < .05$; and for DOL_1 x paradigm, $F(4,198) = 8.17$, $p < .001$. Nonsignificant m x DOL_1 ($p > .05$) and m x DOL_1 x paradigm ($p > .25$) interactions were obtained. The m x paradigm and DOL_1 x paradigm interactions were further analyzed using the Newman-Keuls test for post-hoc comparisons with α controlled at the .05 level of significance.

For the m x paradigm interaction means comparisons between high and low m performance across levels of DOL_1 were nonsignificant in both the B-A and B-C paradigms. In the C-A paradigm, however, performance was significantly superior in low as compared to high m conditions. Analysis of the DOL_1 x paradigm interaction revealed positive transfer in the B-A paradigm to be an increasing function of increasing DOL_1 with superior performance under high as compared to either intermediate or low DOL_1 which did not differ. In both the C-A and B-C paradigms decreasing positive and increasing negative transfer was observed as DOL_1 varied from low to high. Comparison of the interaction means indicated that performance in the C-A paradigm with low DOL_1 was superior to performance in the intermediate and high C-A conditions which did not differ. In the B-C paradigm only the comparison between B-C low and B-C high achieved significance.

The comparisons within both the C-A and B-C paradigms support the prediction derived from a component process model of varying net transfer effects, with increased first-list practice producing increased associative interference. In addition the analyses would suggest that in the C-A paradigm this associative learning proceeds more rapidly with high than with low m materials.

The percentage of transfer analysis used to assess performance within the three experimental paradigms B-A, C-A and B-C prohibited comparisons with the C-D conditions since these group means were the base from which the transformed scores were derived. For this reason Dunnett's test for comparisons with a control group was used to assess positive and negative transfer effects in the experimental paradigms relative to each of the C-D conditions determined by the combination of m and DOL_1. Using mean total errors (see Table 2) and $\alpha = .05$ these tests revealed significant positive transfer in each of the six B-A paradigm conditions. In the C-A paradigm significant positive transfer was observed in the high m low DOL_1 condition with a trend toward significance in the low m low DOL_1 condition (critical value = 39.85). Increased DOL_1 resulted in decreased positive transfer in the low m conditions with C-A versus C-D comparisons at intermediate and high DOL_1 levels both being nonsignificant. With high m materials on the other hand increased first-list practice in the C-A paradigm produced significant negative transfer with intermediate DOL_1 and a trend toward significance with high DOL_1 (critical value = 14.41). Performance in the B-C paradigm with high $\underline{m}$ materials was equivalent to C-D with low and intermediate DOL_1; however, high DOL_1 produced a trend toward significant negative transfer (critical value = 14.41). Similar results were obtained for the B-C and C-D comparisons involving low $\underline{m}$ materials with positive and negative transfer trends in the low (critical value = 39.95) and high (critical value = 37.34) DOL_1 conditions respectively failing to achieve significance. The comparison between B-C and C-D with low $\underline{m}$ and intermediate DOL_1 was nonsignificant.

Stage Analysis of Second-List Acquisition

In order to assess the course of transfer in the early (response learning) and later (associative learning) phases of second-list acquisition, a stage analysis (Kennelly, 1970; Underwood and Schulz,1960) was performed. The typical procedure in transfer of training investigations has been to continue second-list practice for some specified number of trials rather than to a learning criterion (e.g., one perfect recitation) with response learning being measured by the number of trials required for a response to first-appear anywhere in the list (trial of first occurrence) and associative learning being measured by the additional number of trials required for the response to appear as a correct anticipation (Underwood and Schulz, 1960). This procedure however, results in an overestimation of response learning and an underestimation of associative learning effects, (Ekstrand, 1966). In addition Underwood, Ekstrand and Keppel (1965) and Kennelly (1970) have argued that the contribution of first-list stimulus differentiation to transfer should be most apparent during the associative learning stage of second-list acquisition and thus are inadequately reflected by the traditional stage analysis measures. Accordingly, the present experiment incorporated a one perfect (6/6 correct) second-list criterion and an associative error measure first derived by Kennelly (1970). With response learning measured by the usual mean trial of first occurrence the associative error score was defined in terms of the total number of errors for each pair between the first appearance of the response anywhere in the list and the criterion trial. The means and standard deviations for these data are presented in Tables 3 and 4. Figure 5 depicts the percentage of transfer

Insert Tables 3 and 4

during second-list response and associative learning computed from group means.

Insert Figure 5 about here

Response learning. The percentage of transfer data for second-list response learning, computed from the mean trial of first-occurrence data, were analyzed in a completely randomized 2 (high or low *m*)' x 3 (low, intermediate of high DOL_1) x 3 (B-A, C-A or B-C) factorial analysis of variance. This analysis revealed a significant main effect F-ratio for type of paradigm, $F(2,198)=48.169$, $p<.0001$; and a significant DOL_1 x paradigm interaction, $F(4,198)=4.837$, $p<.01$. The remaining main effect and interaction F-ratios were nonsignificant (all *p*s>.05). Descriptively, from the DOL_1 x paradigm interaction means, performance in the B-A paradigm was an increasing function of increasing first-list practice. In both the C-A and B-C paradigms on the other hand increasing DOL_1 produced decreasing positive followed by increasing negative transfer. However, the Newman-Keuls test for post-hoc comparisons ($\alpha=.05$) revealed that differences between DOL_1 levels within the B-A, C-A and B-C paradigms were nonsignificant. In comparisons between paradigms, B-A was superior to both C-A and B-C with intermediate and high levels of DOL_1.

Dunnett's test for comparison with a control group, computed on the mean trial of first occurrence data (see Table 3) revealed significant positive transfer in the B-A paradigm with high *m* and low, intermediate and high DOL_1. Using low *m* materials significant positive transfer was observed for the intermediate and high DOL_1 conditions with a trend toward significance following low DOL_1 (critical value = 4.4). In the C-A paradigm trends toward positive transfer with high *m* and low DOL_1 (critical value = 1.37) and negative transfer with high *m* and high DOL_1 (critical value = 1.44) failed to achieve significance. Using low *m* materials all C-A versus C-D comparisons were nonsignificant. All C-D comparisons with the B-C paradigm were also nonsignificant. However, with low *m* and high DOL_1 (critical value = 3.33) a trend toward significant negative transfer was observed.

Associative Learning. The percentage of transfer data derived from the associative error scores were analyzed in a completely randomized 2 (high or low *m*) x 3 (low, intermediate or high DOL_1) x 3 (B-A, C-A, or B-C) factorial analysis of variance. This analysis revealed significant main effect F-ratios for DOL_1, $F(2,198)=6.497$, $p<.005$; and for type of paradigm, $F(2,198)=21.995$, $p<.0001$, but the effect from *m* was nonsignificant ($F<1$). This analysis also revealed a significant DOL_1 x paradigm interaction $F(4,198)=5.830$, $p<.01$. The *m* x DOL_1 and *m* x paradigm interactions both approached significance ($ps<.10$) while the *m* x DOL_1 x paradigm interaction failed to achieve significance ($F<1$). The post-hoc analysis of the DOL_1 x paradigm interaction means revealed significant comparisons between the B-A and both the C-A and B-C paradigms with high DOL_1. In the C-A paradigm the observation of decreasing positive and increasing negative transfer as a function of increasing DOL_1 was supported by significant comparisons between C-A low and C-A intermediate and between C-A low and C-A high group means. A similar effect observed in the B-C paradigm was supported by significant comparisons between B-C low and B-C high and between B-C intermediate and B-C high.

Dunnett's test for comparisons with a control group, computed on the associative error scores (see Table 4), revealed significant positive transfer in the B-A paradigm with low _m_ materials and low and high levels of DOL_1. The absence of significant B-A transfer in the high _m_ conditions resulted from a ceiling effect on positive transfer in this analysis since the critical value computed from Dunnett's test required fewer than zero associative errors to be declared significant. In the C-A paradigm comparisons with C-D varied from a positive trend with low _m_ and low DOL_1 (critical value = 31.14) to significant negative with high _m_ and intermediate DOL_1. The C-A high _m_ high DOL_1 negative transfer trend (critical value = 7.17) did not achieve significance. In comparisons between C-D and B-C, transfer was observed to vary from significant positive in the low _m_ low DOL_1 condition to significant negative in the high _m_ high DOL_1 condition.

In general the observation of varying positive and negative transfer effects in the associative stage of second-list learning for both the C-A and B-C paradigms supports the hypothesis that the secondary variables _m_ and DOL_1 interact to determine the relative contribution from each of the component process variables. The stage analysis data also support the Underwood, Ekstrand and Keppel (1965) hypothesis that stimulus differentiation effects should be most apparent during the associative learning stage of second-list acquisition. In fact, with low *m* materials and low DOL_1 performance in the B-C paradigm was equivalent to that observed in the B-A paradigm, both paradigms being significantly superior to C-D.

Intralist Intrusions

The mean percentage of intralist intrusions (misplaced responses) during the learning of the second-list to a 6/6 correct criterion was analyzed in a completely randomized 2 (high or low *m*) x 3 (low, intermediate or high DOL_1) x 4 (B-A, C-A, B-C or C-D) factorial analysis of variance. The percentages were based on the number of intrusions relative to the number of opportunities (total responses) during second-list learning. This analysis revealed a significant effect only for the paradigm variable, $F(3,264)=8.08$, $p<.001$. The remaining main effect and interaction F-ratios were nonsignificant (all *ps*>.05). The mean percentage of intrusions for the B-A, C-A, B-C and C-D paradigms respectively were 6.51, 12.48, 8.68 and 9.33. The Newman-Keuls test for post-hoc comparisons revealed that significantly fewer intrusions occurred in the B-A paradigm relative to the C-D and C-A paradigms. The B-A versus B-C comparison was nonsignificant. In addition the observation of increased intrusion rates for *Ss* in the C-A paradigm was supported by significant comparisons with each of the paradigms B-A, B-C and C-D. Thus response item availability would seem the critical variable in this analysis reflecting associative facilitation and interference effects in the B-A and C-A paradigms respectively.

Discussion

Substantial statistical and descriptive support was afforded the component process model by the present data. The hypothesis derived from the model that transfer effects within a particular paradigm are determined by an interactive relationship existing between the secondary variables of meaningfulness and the degree of first-list learning was substantiated by the observation of varying positive transfer in the B-A paradigm and both positive and negative transfer effects in the C-A and B-C paradigms. In general, the results of the present experiment accentuate the relevance of a component process analysis of net transfer effects and in particular extend the utility of such an approach to include the S_1-R_2 and S_2-R_1 paradigms.

B-A Transfer

Regarding specific paradigm effects obtained in the present experiment, performance in the B-A paradigm was observed to be an increasing positive function of increasing DOL_1 for both low and high _m_ conditions. Relative to performance in the appropriate control condition, B-A transfer was observed to be solely positive and in agreement with previous results reported by Houston (1966a; 1966b) and Murdock (1956). Collectively these data support the component process model prediction of positive transfer in the B-A paradigm covarying with the secondary variable manipulations involved since increased contributions from any one of the four transfer components, St, R, F, or B, is always positive. The percentage of transfer data would further suggest that with low levels of DOL_1 the contributions to B-A transfer derive largely from the St and R component process variables. This interpretation is particularly tenable given the absence of differences in comparisons between the B-A, C-A, and B-C paradigms with low DOL_1 across low and high _m_ conditions. The component process model as developed by Martin (1965) incorporates the assumption that in the paired-associate task response learning precedes and overlaps associative learning (Underwood and Schulz, 1960). Thus with low DOL_1 comparatively less associative facilitation (for B-A) or interference (for C-A and B-C) is transferred from first-list learning. With increased DOL_1 however differences between paradigms become apparent as the F and B component process variables begin to assume their predicted curvatures. This prediction is supported from both the percentage of transfer and stage analysis since significant differences were obtained in comparisons between B-A, C-A and B-C paradigms in the intermediate and high DOL_1 conditions but not in the low DOL_1 condition.

C-A Transfer

Martin's (1965) conception of the component process model of transfer for the S_1-S_2 and R_1-R_2 paradigms considered only first-list response learning in relationship to DOL_1 and the temporal development of A-B and B-A associations. Clearly from the present data a stimulus differentiation variable must be incorporated in the model to achieve a component process analysis of transfer in the S_1-R_2 and S_2-R_1 paradigms since significant positive and negative net transfer effects in the C-A paradigm were observed to vary as a function of increasing DOL_1. Relative to C-D, Dunnett's test applied to total errors revealed significant positive transfer for high _m_ low DOL_1 and significant negative transfer with high _m_ and intermediate DOL_1. This would suggest that the differentiation of first-list stimuli, and thus the strength of the St component, precedes first-list associative learning in temporal development. The implication for paired-associate learning in general is that both response learning and stimulus differentiation precede and overlap the acquisition of specific A-B and B-A associations.

Descriptively, performance in the C-A paradigm across m x DOL_1 conditions was similar to the existing literature for performance in the traditional C-B paradigm. With low DOL_1 and both high and low m materials, C-A performance was superior to that observed in the C-D paradigm. Similar results using low m materials have been reported for the C-B paradigm by Homzie, et. al. (1969), Jung (1963) and Merikle (1968). Using high m materials Dean and Kausler (1964) have reported positive transfer in the C-B paradigm with low DOL_1 (3/6 correct).

Net transfer effects in the C-A paradigm varied as DOL_1 increased, resulting in a shift from significant positive to significant negative transfer with high m materials and decreased positive transfer with low m materials. Collapsing across levels of m the percentage of transfer analysis confirmed that this decrease was significant. Additionally this analysis revealed a significant difference between low and high m conditions across levels of DOL_1. Similar negative transfer effects have been observed in the C-B paradigm when high m materials are employed (Dallet, 1962; Goulet and Behar, 1965; Johnston, 1968; Kausler and Kanoti, 1963). In both the C-A and C-B paradigms then, the interaction of m and DOL_1 has been observed to produce either positive or negative net transfer effects, with high levels of m and DOL_1 functioning to enhance the contribution from first-list associative learning.

The present data, and those of Goulet and Barclay (1965), Homzie, et. al. (1969), Murdock (1958), and Schulman (1967c) are in sharp contrast to the prediction of zero transfer in the C-A paradigm derived from Houston's (1964) S_1-R_2, S_2-R_1 transfer surface. They suggest rather that the secondary variables of m and DOL_1 can function to either enhance or diminish the relative contribution from the St and F component process variables producing either positive or negative net transfer effects.

Harcum (1953), using a two perfect first-list criterion, a condition which should enhance the development of the F component, reported results which are discrepant with the predictions derived from a component process model. Harcum's data supported the prediction of zero transfer in the C-A paradigm. The present experiment replicated this effect with low _m_ materials and intermediate (6/6 correct) and high (6/6 + 50%) DOL_1. This result would suggest that when low _m_ materials are involved, the contribution to transfer from the F component process variable is mitigated.

A similar mitigating effect has been observed in the traditional A-C paradigm with increasing DOL_1 producing zero transfer relative to C-D (Postman, 1971), rather than the increasing negative transfer predicted from Martin's component process model. Martin (1968) and Kausler (1974) have recognized the complication in attempting to relate stimulus differentiation and associative learning effects to net transfer when low _m_ materials are involved. These authors have argued that a direct relationship exists between the _m_ level of the stimulus unit and the amount of associative interference produced during A-C acquisition. Martin (1968) has proposed an encoding variability hypothesis which suggests that associative learning in the PA task varies as a function of perceptual encoding responses which are made to a particular stimulus item. The perceptual encodings possible from a high _m_ stimulus is hypothesized to consist of a single unitary element while the number of encodings possible with a low _m_ stimulus are assumed to be numerous. Using this logic Martin suggests that the amount of negative transfer observed should decrease as a function of decreasing stimulus _m_ since "....low _m_ stimuli can be encoded in a greater variety of ways than can high _m_ stimuli, and hence can provide more alternative recoding routes in a negative transfer situation (p. 432)". Bryk and Kausler (1966) have drawn a similar distinction between the nominal stimulus defined by the experimenter and the functional stimulus employed by the S. They have succinctly summarized the resulting effects, "if, under low m, a different element of the nominal stimulus is selected as the cue during second-list acquisition the two lists enter into a A-B, C-D rather than an A-B, A-C relationship (p. 918)". The implication is of course mitigated associative interference when low m first-list stimuli are present during second-list learning relative to conditions where high m stimuli are transferred. For the present data this hypothesis would suggest that the nominal C-A paradigm was in fact a functional C-D paradigm in those conditions where low m stimuli were transferred and associative interference was predicted, i.e., with intermediate and high DOL_1. This hypothesis would further suggest reduced positive transfer effects with the C-A paradigm in low m and low DOL_1, conditions, relative to performance in a C-A paradigm with high m and low DOL_1 or a C-B paradigm with either high or low m. This would follow since functional stimuli are being transferred in the C-A paradigm while the task requires the recall of the nominal stimuli. This ad hoc prediction was supported in the present data. Dunnett's test on total errors revealed significant positive transfer for the C-A paradigm with low DOL_1 and high m, however, with low m this trend failed to achieve significance. Additionally the stage analysis revealed a trend towards significant positive transfer during the response learning stage of second-list acquisition in the low DOL_1 high m condition and a marked absence of response learning effects with low m materials (see Figure 5).

B-C Transfer

The existing literature, as does Houston's net transfer surface, suggests that transfer in the B-C paradigm is solely negative. Houston

(1966a; 1966b) and Murdock (1958) have reported negative transfer in the B-C paradigm using high *m* materials and intermediate and high levels of DOL_1 respectively. With low *m* materials negative B-C transfer has been reported by Goulet and Barclay (1965) using an extended first-list practice criterion (three perfect trials). Similar descriptive results were evidenced in the present data with corresponding *m* and DOL_1 conditions, i.e., negative B-C transfer with high *m* materials and intermediate or high DOL_1 and with low *m* materials and high DOL_1. Collectively this evidence would suggest that the B-C paradigm is a negative transfer paradigm producing net transfer effects similar to those observed in the traditional A-C paradigm (Crouse, 1968; Jung, 1962; 1967; Postman and Stark, 1969). When the remaining B-C paradigm conditions from the present experiment are considered, however, quite a different picture emerges with low DOL_1 conditions producing net transfer effects which are positive, in comparison to the appropriate C-D control condition, for both high and low *m* materials. While Dunnett's test on total errors revealed that these differences were also nonsignificant, the trends toward positive transfer with low DOL_1 and negative transfer with high DOL_1 are apparent in the data. The percentage of transfer analysis confirmed a significant difference between low and high DOL_1 conditions across levels of *m* in the B-C paradigm.

Houston (1964) has suggested that the B-C paradigm is analogous, in terms of net transfer effects, to the traditional A-C paradigm. The present data however, would suggest quite a different interpretation. With low DOL_1, the trend toward positive net transfer effects in the B-C paradigm and the observation of significant positive transfer during the associative learning stage of second-list acquisition is not evidenced by the existing literature for the A-C paradigm (Jung, 1962; Mandler and Heinemann, 1956; Postman, 1962). In addition the trend toward negative transfer in B-C with intermediate and high DOL_1 did not achieve significance. In fact, the percentage of transfer and stage analysis data indicate greater backward associative interference in the C-A paradigm than forward associative interference in the B-C paradigm with high m materials and intermediate DOL_1, a prediction which certainly would not be supported in comparing the traditional C-B and A-C paradigms.

There are two apparent reasons for this disanalogy between the A-C and B-C paradigms, suggested by a component process analysis of transfer, both of which stem from the nature of the paired-associate learning task itself. First, the contribution to second-list stimulus differentiation, a positive component, from first-list response learning should be stronger in the B-C paradigm since these second-list stimulus items functioned as first-list responses and had to be differentiated to achieve the associative stage. In the PA task, using the anticipation method, the S must learn to fully differentiate and integrate the responses in the list since these items must be recalled during the test interval. The differentiation of stimuli on the other hand procedes as a recognition-discrimination task since the S is never required to recall these items. Thus Ss in an A-C paradigm condition are transferring a positive component which developed from a first-list recognition task while B-C Ss are transferring a positive component from a first-list recall task. A component process analysis would suggest then that the contribution to second-list stimulus differentiation is greater in the B-C as compared to the A-C paradigm as a function of differences in item availability (Kanak and Neuner, 1970).

A second reason for the apparent disanalogy between the A-C and B-C paradigms concerns the relative strength of the first-list associations transferred to second-list learning. In the A-C paradigm what is being transferred is the tendency for A, the old stimulus, to elicit B, the old response, in competition with C, the new response. In the B-C paradigm on the other hand the tendency for B to elicit A in competition with C is transferred from first-list learning. There is good evidence to suggest that in the PA task these forward (A-B) and backward (B-A) associative strengths are not equivalent (Crouse, 1968; Kausler, 1974). Kanak and Neuner (1970) have argued that this asymmetry results from the methodology of the PA task itself, "...the anticipation method, or any other method of acquisition which mixes recall and recognition processes, does not satisfy the assumption of equal item availability and also favors asymmetry as a result of the performance set favoring the recalled item (p. 288)." Crouse (1968) has also presented convincing evidence which suggests that backward associative interference in the C-B and $A\text{-}B_r$ paradigms is approximately two-thirds as strong as the forward associative interference observed in the A-C and $A\text{-}B_r$ paradigms. In summary, a component process analysis of transfer in the B-C and A-C paradigms would suggest a stronger stimulus differentiation component and a weaker associative interference component in the B-C paradigm. This leads to the interactive prediction of greater positive transfer with low DOL_1 and less negative transfer with high DOL_1 for performance in the B-C relative to the A-C paradigm, a prediction which needs to be tested experimentally.

Despite the disanalogy between the A-C and B-C paradigms an obvious similarity exists since new response items must be acquired during second-list learning in both paradigms and any positive contributions to transfer must result from facilitated stimulus differentiation. The role of stimulus differentiation in A-C transfer has been investigated in a recent series of experiments reported by Underwood and Ekstrand (1968), Underwood and Freund (1968) and Kennelly (1970). While attempts to demonstrate positive transfer in the A-C paradigm have been largely unsuccessful, Kennelly (1970) has argued that the positive contribution to second-list stimulus differentiation should be most apparent during the associative stage of transfer since both A-C and C-D Ss must first learn new response items, a task which occupies the initial acquisition trials. Using a second-list criterion of one perfect recitation, rather than the typical limited block of trials, and an associative error measure for the stage analysis, Kennelly's data revealed a significant positive transfer effect during the associative stage of A-C learning under conditions of high intralist stimulus similarity. In addition a second measure of associative learning, intralist response intrusions, reflected a similar positive transfer effect with fewer intrusions during A-C as compared to C-D acquisition. This prediction follows since a positive contribution to stimulus differentiation should reduce the tendency to confuse second-list stimuli and respond with an incorrect item from elsewhere in the list. The data from the present experiment replicated these effects using the B-C paradigm with low m materials and low DOL_1. The stage analysis of second-list learning revealed significant positive transfer in both the B-C and B-A paradigms during the associative learning stage of transfer. The respective percentage of transfer means were 24.08 and 27.72. In addition the intralist intrusion data support the prediction that the stimulus differentiation contributions to transfer is stronger with low than with high m materials. The respective B-C and C-D percentage of intrusion means with low DOL_1 were, 10.20 and 11.04 for high m and 7.81 and 9.82 for low m. The B-A intrusion means for the same conditions were 8.17 and 8.14. These data would suggest that with low m materials and low DOL_1 the contribution to associative learning via facilitated stimulus differentiation is at least as strong in the B-C as in the B-A paradigm. While experimental evidence is lacking, this equivalence between the B-A and B-C paradigms during second-list associative learning in the present experiment would suggest that the stimulus differentiation contribution to transfer is stronger in the B-C than in the A-C paradigm. This prediction is suggested for two reasons: (1) the second-list stimuli in the B-C paradigm are transferred from a first-list recall task which should prohibit encoding effects since response items must be fully integrated to achieve criterion and (2) response competition effects should be weaker in the B-C paradigm given the asymmetrical relationship between the strength of the B-A and A-B associations. This should be particularly true with low _m_ and low or intermediate values of DOL_1.

Comparison Between Paradigms

The percentage of transfer analysis revealed nonsignificant difference between the C-A and B-C paradigms for both the DOL_1 x paradigm interaction and for the _m_ x paradigm interaction in agreement with predictions derived from a component process model. Descriptively, with high _m_ materials increasing DOL_1 produced decreasing positive and increasing negative transfer in both the C-A and B-C paradigms. With high _m_ and high DOL_1 the C-A and B-C percentage of transfer means were -17.98 and -16.70 respectively. This negative transfer equivalence with high _m_ materials replicates the results reported by Murdock (1958).

Goulet and Barclay (1965) using low _m_ and high DOL_1 (a 3-perfect criterion) observed performance in the C-A paradigm to be inferior to performance in the B-C paradigm. The opposite results have been reported by Harcum (1953) who also employed high DOL_1. It was previously suggested that in the C-A paradigm the effects of associative interference, resulting from the contribution of the F component to transfer, were mitigated by encoding variability in the low _m_ high DOL_1 condition. In line with Martin's (1968) hypothesis however, encoding variance would not be predicted in the B-C paradigm since these second-list stimuli function as first-list responses. The use of stimuli acquired from a first-list recall task is a procedure which would be expected to prohibit encoding variability and thus the possibility of recoding during transfer. In the B-C paradigm then the B component and hence associative interference would be enhanced relative to similar m and DOL_1 conditions in the C-A paradigm with the result of greater negative transfer for B-C.

The Goulet and Barclay (1965) results however, are discrepant with the foregoing analysis. This experiment involved the use of low m materials with meaningfulness being defined in terms of English word frequency. In addition their procedure involved the use of a mixed-list design with both control and experimental pairs present in the C-A and B-C transfer lists. Harcum (1953) and the present experiment on the other hand used CVC materials and an unmixed-list procedure. It seems probable that the observed performance differences between these experiments resulted from the materials used to define meaningfulness and/or the mixed-unmixed list differences. It is also possible that pronounceability of the stimulus item is critical to the encoding process hypothesized by Martin (1968). Several recent experiments using traditional paradigms have also pointed to the importance of materials and list construction procedures in relationship to encoding variability effects (Goggin and Martin, 1970; Martin, 1971; Carlton and Grenno, 1970; Read and Scarlett, 1973; Weaver, McCann and Wehr, 1970; Williams and Underwood, 1970).

Conclusions

The data from the present experiment would suggest that transfer in the S_1-R_2 and S_2-R_1 paradigms results from the contribution of specific component process variables whose relative strength is determined by the interaction of m and DOL_1 which can function to either mitigate or enhance the effects predicted from a net transfer surface (Houston, 1964). This conception of transfer both generates specific testable predictions and accomplishes an integrative function for empirical data. Additionally, the component process model offers a conceivably important avenue for the systematic investigation of phenomena assumed to affect performance in the S_1-S_2 and R_1-R_2 paradigms. The existing data would suggest particular relevance for encoding variability predictions and the assessment of stimulus differentiation, response learning, and associative contributions to net transfer.

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Table 1

Means and Standard Deviations for Second-List

Trials to Criterion

$\underline{m}$	DOL_1	Paradigm							
		B - A		C - A		B - C		C - D	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
HIGH	LOW	9.50	5.28	10.50	3.86	10.42	4.15	13.75	6.95
	INTERMEDIATE	6.58	2.53	14.50	6.10	10.33	4.55	9.08	3.35
	HIGH	5.33	2.78	14.33	7.17	14.83	6.61	10.17	5.23
LOW	LOW	31.75	14.29	37.67	10.67	38.50	14.22	47.92	15.12
	INTERMEDIATE	26.00	9.31	35.92	8.19	31.58	7.41	37.83	13.50
	HIGH	17.83	7.19	32.33	10.99	44.75	8.31	37.83	13.47

Table 2

Means and Standard Deviations for Second-List

Total Errors

m	DOL_1	Paradigm							
		B - A		C - A		B - C		C - D	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
HIGH	LOW	24.92	14.95	29.50	13.59	34.42	17.31	42.40	18.86
	INTERMEDIATE	15.17	7.22	42.42	18.77	33.16	17.89	27.00	12.75
	HIGH	11.41	5.31	41.17	20.47	40.17	18.26	28.67	13.73
LOW	LOW	112.00	53.26	139.50	44.64	140.08	61.99	172.58	58.13
	INTERMEDIATE	77.75	24.74	120.67	27.63	109.33	39.00	128.75	52.02
	HIGH	51.92	25.94	110.90	49.19	158.42	30.81	127.90	52.16

Table 3

Means and Standard Deviations for Trials to Criterion

During Second-List Response Learning

m	DOL_1	Paradigm							
		B - A		C - A		B - C		C - D	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
HIGH	LOW	3.81	2.02	4.13	.92	4.61	1.27	5.33	1.63
	INTERMEDIATE	2.59	.68	5.29	1.27	4.27	1.32	4.55	1.66
	HIGH	2.18	.65	5.74	2.04	5.18	1.86	4.66	1.50
LOW	LOW	11.31	4.95	14.26	3.38	16.01	5.99	15.33	4.83
	INTERMEDIATE	7.55	2.62	12.15	3.77	11.40	4.55	12.50	4.48
	HIGH	6.96	3.25	10.59	3.73	15.51	3.44	12.62	4.22

Table 4

Means and Standard Deviations for Second-List

Total Errors During Associative Learning

m	DOL_1	Paradigm							
		B - A		C - A		B - C		C - D	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
HIGH	LOW	7.00	6.78	10.25	9.49	11.00	12.52	15.91	12.54
	INTERMEDIATE	4.59	5.60	16.25	13.82	8.33	6.89	6.83	8.63
	HIGH	2.92	5.07	12.50	11.47	15.50	11.28	6.41	6.46
LOW	LOW	48.66	29.14	58.75	29.07	47.25	27.46	86.00	47.94
	INTERMEDIATE	39.17	24.36	53.08	15.25	48.08	29.13	62.00	32.84
	HIGH	16.37	12.00	51.91	32.76	73.08	35.59	60.00	46.15

Figure Captions

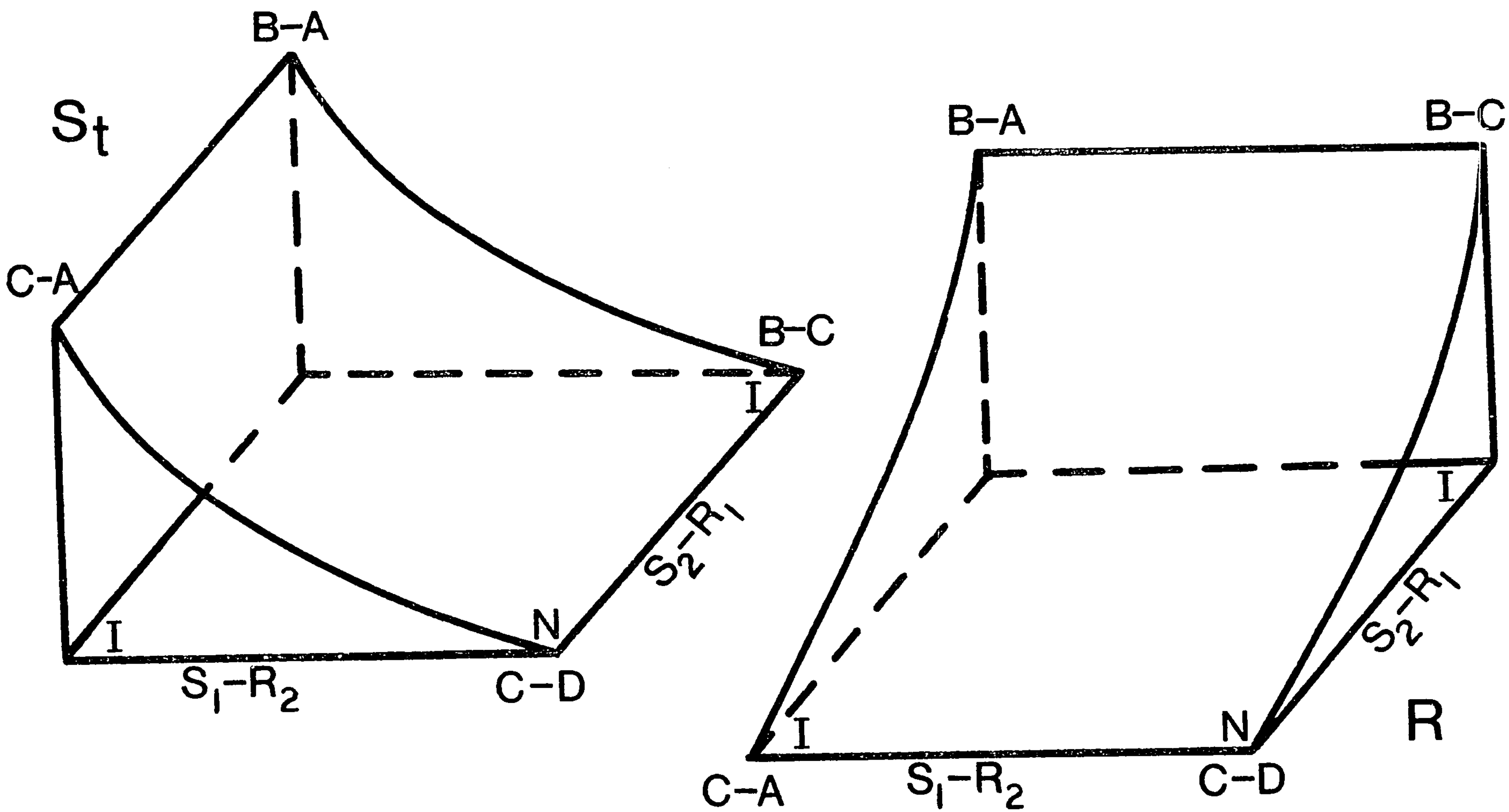
Figure 1. The component process surfaces for: (St) the effect of first-list stimulus differentiation on second-list response learning, and (R) the effect of first-list response learning on second-list stimulus differentiation, defined for varying degrees of S_1-R_2 and S_2-R_1 similarity.

Figure 2. The component process surfaces for: (F) the effect of first-list forward associative learning on second-list acquisition, and (B) the effect of first-list backward associative learning on second-list acquisition, defined for varying degrees of S_1-R_2 and S_2-R_1 similarity.

Figure 3. Maximum positive and negative net transfer predictions determined by the relative contribution from the St, R, F and B component process variables for varying degrees of S_1-R_2 and S_2-R_1 similarity. The positive surface (—— - ——) is obtained when the secondary variables $\underline{m}$ and DOL_1 function to maximize the St and R, and minimize the F and B contributions to transfer. The negative surface (————) is obtained when $\underline{m}$ and DOL_1 function to minimize the St and R, and maximize the F and B contributions.

Figure 4. Percentage of transfer, computed from total errors, in the B-A, C-A and B-C paradigms, relative to the appropriate C-D control condition, for each of the $\underline{m}$ x DOL_1 factorial combinations.

Figure 5. Percentage of transfer during the response and associative learning stages of second-list acquisition in the B-A, C-A, and B-C paradigms for each of the $\underline{m}$ x DOL_1 factorial combinations.


S_t
B–A
C-A
B–C
I
N
I
S_2–R_1
S_1–R_2
C–D
B–A
B–C
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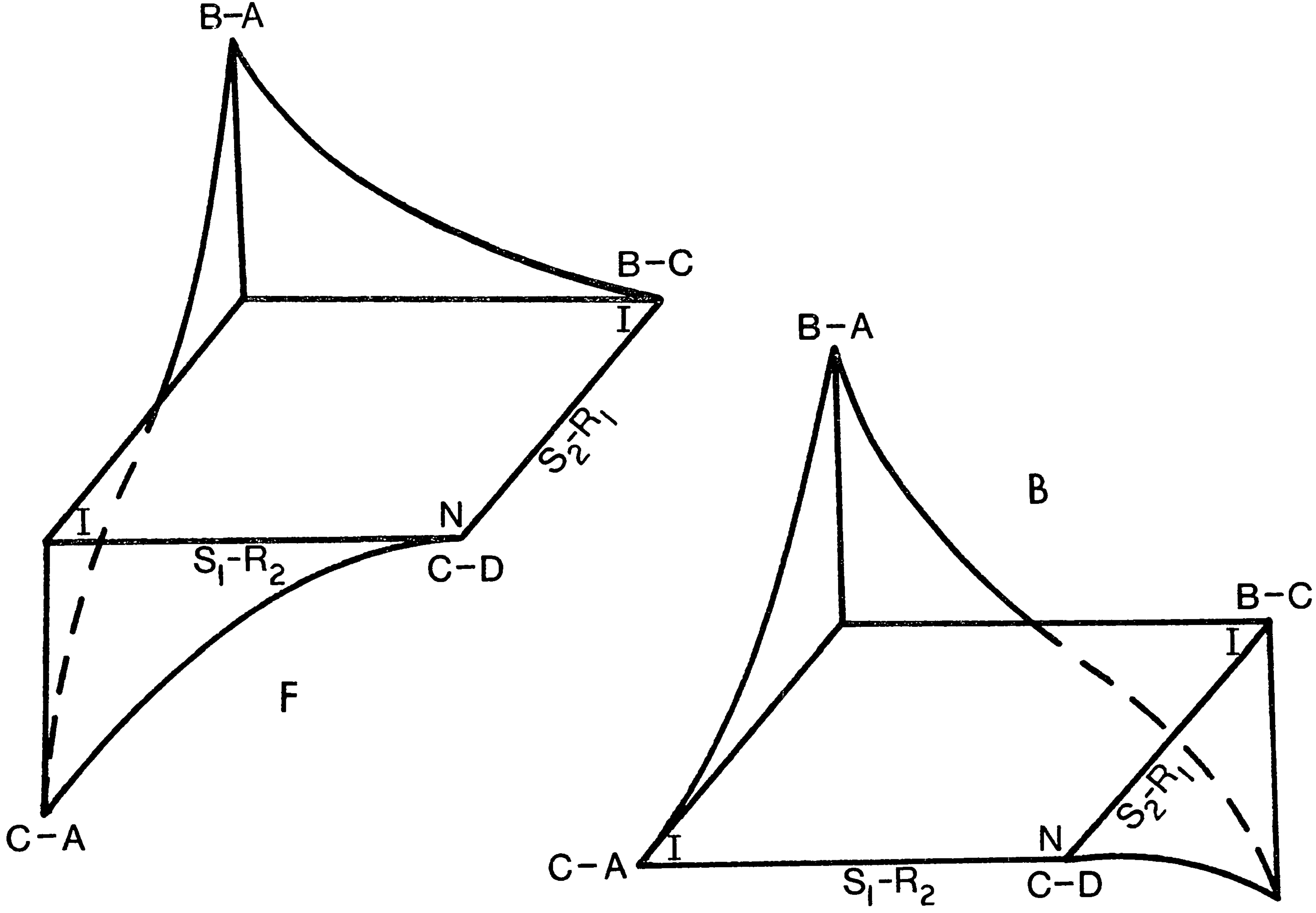
S_1–R_2
C–D


B-A
B-C
I
I
N
S2-R1
S1-R2
C-D
C-A
F
B-A
B
B-C
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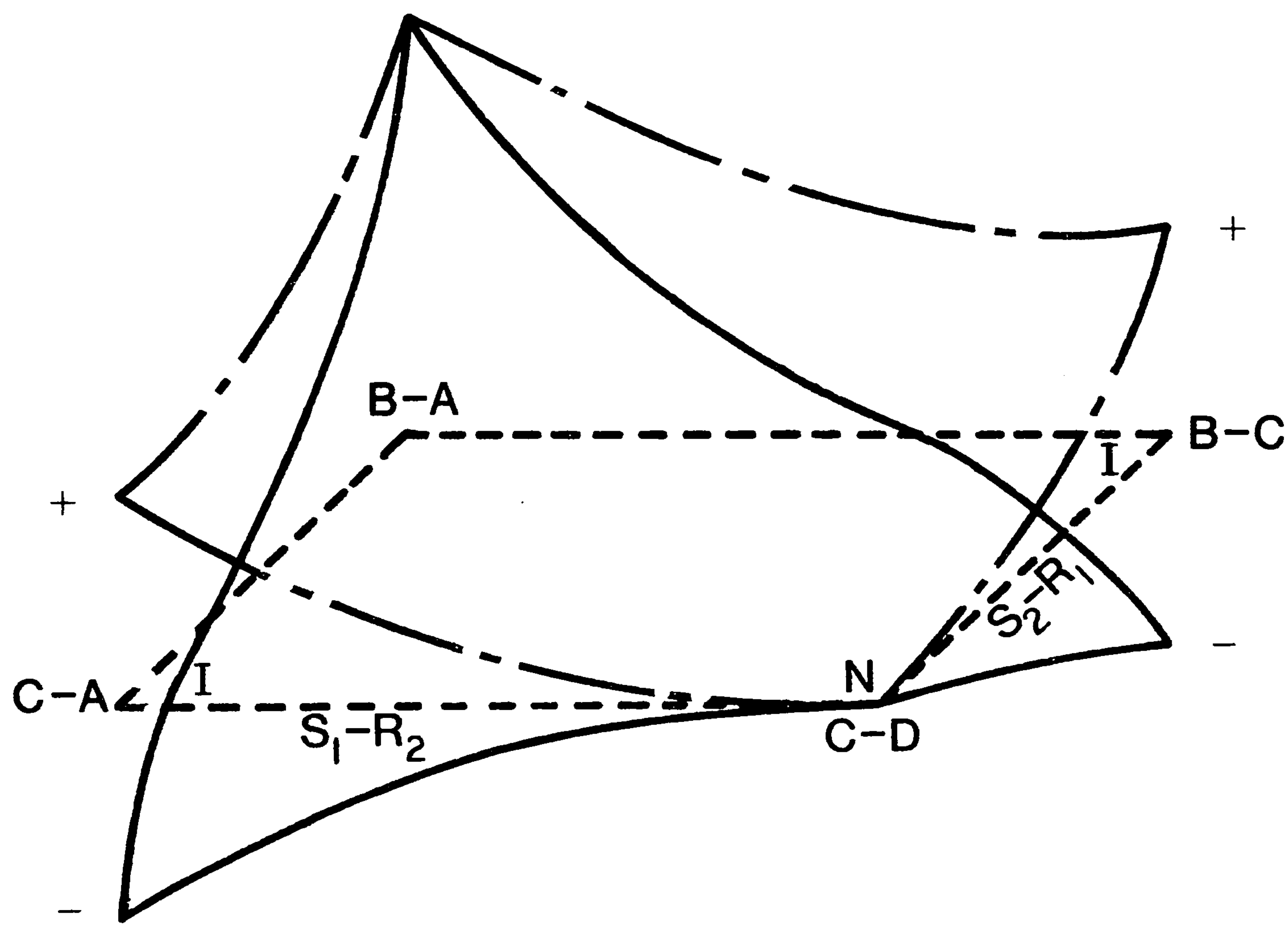
C-A
C-D
B



+
+
+
B–A
B–C
I
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S_2–R_1
N
C–A
S_1–R_2
C–D
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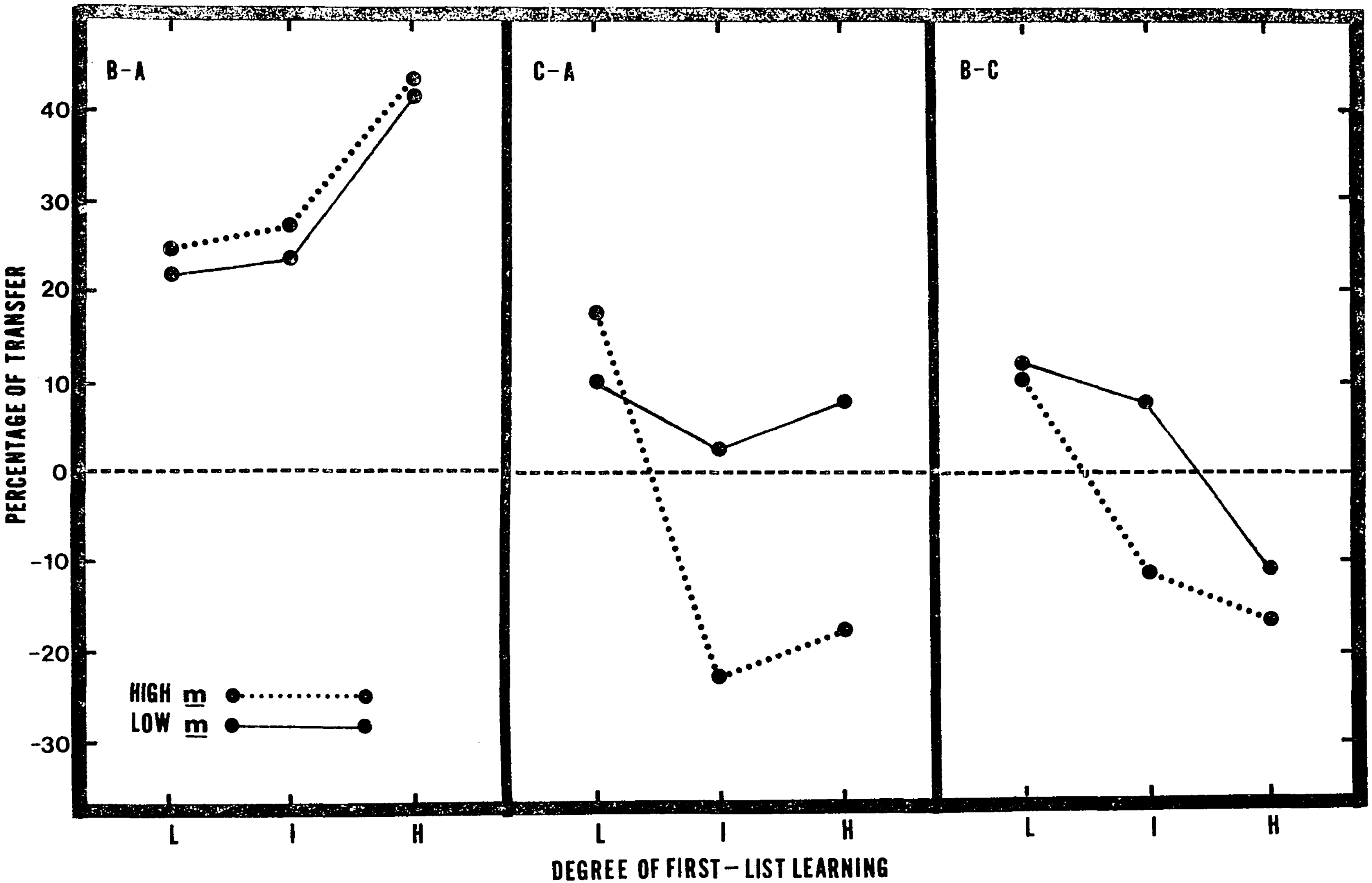
B-A
C-A
B-C
PERCENTAGE OF TRANSFER
40
30
20
10
0
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HIGH m
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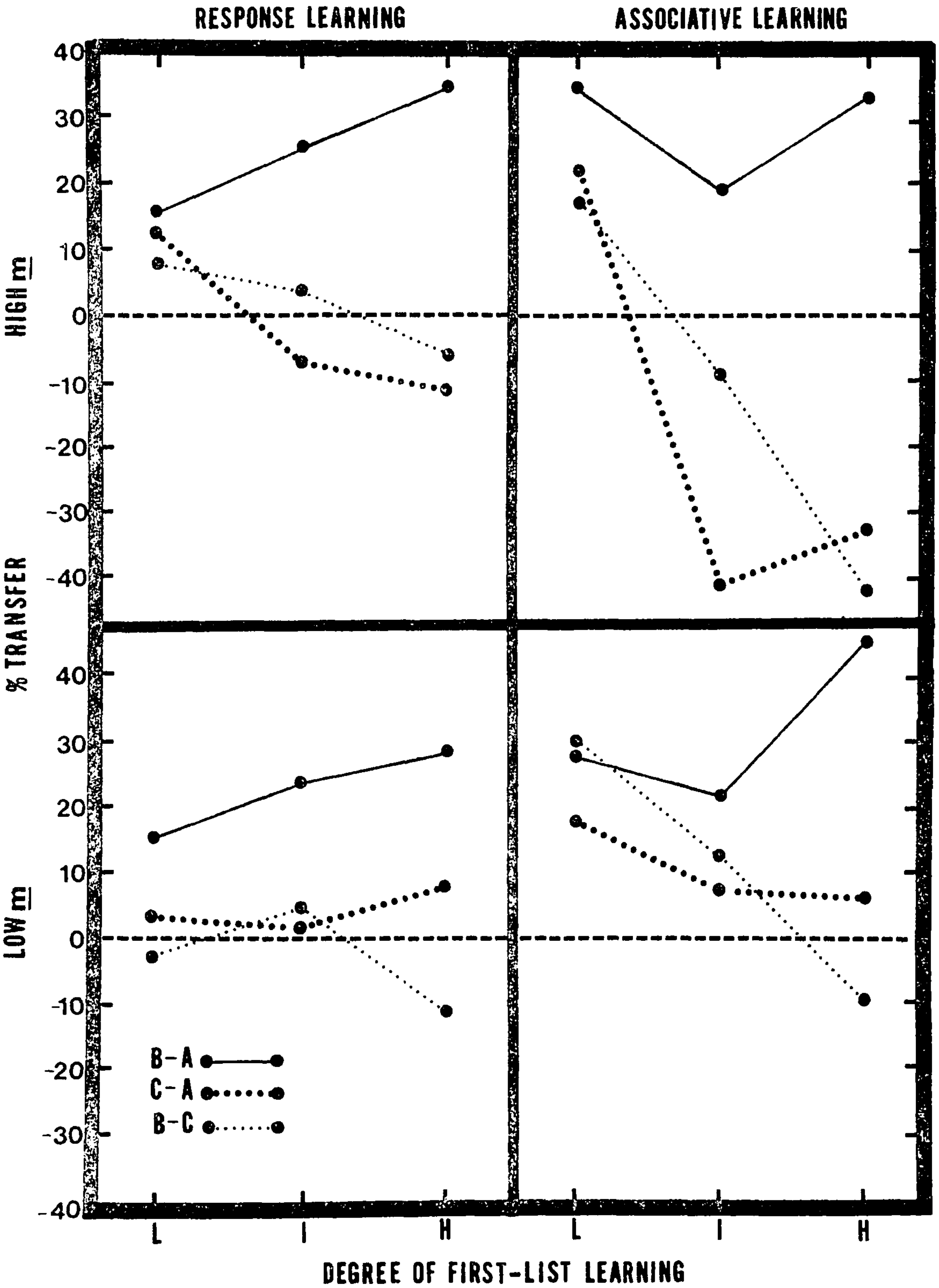
DEGREE OF FIRST-LIST LEARNING


RESPONSE LEARNING
ASSOCIATIVE LEARNING
HIGH m
LOW m
% TRANSFER
40
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DEGREE OF FIRST-LIST LEARNING

APPENDIX A

PROSPECTUS

PROSPECTUS

Transfer of training research in general has its historical origins in theories of education. More specifically it has evolved from an interest in the doctrine of formal discipline (Postman, 1971) which asserts that maximal benefit, in terms of transfer from one task to another, results when the tasks considered involve similar "mental functions". Early educators adopted the doctrine of formal discipline and in large measure were supported by the proponents of faculty psychology which assumed that the mind is divided up into various mental faculties, such as, a memory faculty, a reasoning faculty etc. (Garrett, 1951). For this reason it was logical for the educator to assume that if a student engages in rigorous mental exercise invoking the use of one of his mental faculties he could facilitate the development of that faculty. Thus, a student who is forced to memorize a large volume of Latin or Greek should develop a most formidable capacity for the retention of more useful information , (Garrett, 1951). In the fields of both education and psychology the doctrine of formal discipline soon fell into disfavor. The first experiment specifically addressed to the problem of transfer of training was reported by William James in 1890. James measured the amount of time required to memorize selections from poems by Hugo and Tennyson both before and after training with other passages. The results indicated little if any improvement.

A more elaborate series of experiments, reported by Thorndike and Woodworth (1901) furnished the first explicit evidence against the doctrine of formal discipline. In each of three different experiments subjects received various types of training in discrimination and perception tasks. The results indicated that even in tasks which were quite similar there was comparatively little improvement. In fact, these investigators observed considerable interference or negative transfer in certain situations, (Garrett, 1951). The work of Thorndike and Woodworth (1901) thus served to discredit the doctrine of formal discipline as a viable account of transfer.

With the emergence of psychology as a behavioral science researchers interested in transfer of training, like James, turned their attention to the verbal learning task in an attempt to identify or isolate specific variables which can affect performance on a subsequently learned task. The two most significant contributions to the study of transfer, the conception of learning in terms of stimulus (St) and response (R) associations and the development of the paired-associate verbal learning task (Calkins, 1894), provided both the theoretical basis and the methodological vehicle for the systematic investigation of inter-task changes in performance. An early experiment which reflected this theoretical orientation was that of Muller and Schumann (1894) which postulated the law of associative inhibition. The subsequent experiments by Reed (1917), Poffenberger (1915), Wylie (1919), Yum (1931), and Bruce (1933) have all demonstrated the theoretical utility of the S-R model for the investigation of transfer phenomena. More recently the labors of Gibson (1940), Osgood (1949), and Martin (1965) have functioned to establish the S-R model as the dominate approach to the analysis of transfer of training in the paired-associate learning task.

The present paper is devoted to a review of transfer in the tradition of S-R associationism. By and large the scope of the paper is limited to a general review of research between 1940-1974 with particular emphasis on research conducted between the years 1960-1974. The review is further restricted, given considerations of length, to the paired-associate (PA) and verbal discrimination (VD) learning tasks. To facilitate ease of presentation the paper is subdivided into seven sections considering separately: (1) Nonspecific transfer effects, (2) Methodological variables, (3) Specific transfer effects, The identification of phenomena, (4) Mechanisms of Transfer I, (5) Mechanisms of Transfer II, (5) Secondary variables, and (7) Verbal discrimination transfer.

Nonspecific Transfer Effects

Early transfer of training research, dating from the doctrine of formal discipline has led to the now well accepted conclusion that both specific and nonspecific transfer components can be identified. Nonspecific transfer (NST) has been defined (Postman, 1971) as improved performance on a transfer list which results from first list learning regardless of the stimulus (St) and response (R) relationships between lists, i.e., NST is defined independent of specific list content. Early NST research has concentrated on two particular phenomena, warm-up (WU) effects and learning-to-learn (LTL) effects. Postman and Schwartz (1964) defined WU effects in terms of the development of a "set" to learn consisting of factors like, postural adjustment, optimal pacing of response emission and increased familiarity with the experimental setting. LTL on the other hand is best characterized by the development of specific learning habits, i.e., adopting an appropriate strategy. Postman (1964) has also indicated that for the PA task LTL transfer effects are largely accounted for in the associative stage (Underwood and Schulz, 1960) of acquisition.

Early Research: The Warm-Up Hypothesis

While the study of transfer in general developed from the doctrine of formal disciplines, research concerning specific NST phenomena derived from a failure to obtain associative interference effects in situations where they were expected. An experiment reported by Heron (1928) first gave rise to the need for separating net transfer effects into different component processes. Heron's experiment was designed to investigate the interfering effects of attaching new responses to old stimuli in the PA task using the A-B, A-C paradigm hereafter referred to as A-C. (Some researchers prefer the notation A-D for this paradigm to avoid confusion when considering the C-B and C-D paradigm where "C" refers to the new second-list stimulus; however, the traditional A-C labelling will be used in the present review). Requiring subjects to learn two different CVC lists each day for three days Heron found that the first list learned on the second day required significantly fewer trials than did the second list from the first days practice, i.e., improved performance across lists. From these data he concluded that first list learning on any given day provided the subject with the opportunity to develop an effective "set" to learn, i.e., warm-up. Thus, the NST effect of WU served to mitigate the expected interference effects of identical stimuli in the A-C paradigm.

Postman (1971) argues that the WU set develops and is maintained for as long as the specific activity involved is continued. In addition, the WU set is thought to dissipate rapidly as soon as the activity is terminated. This temporal definition has come to provide the basis for distinguishing between the WU and LTL components of NST, with LTL being defined in terms of more efficient methods of learning which manifest greater temporal persistance and represent relatively permanent changes in behavior; however this distinction was not readily accepted by early researchers.

Two experiments by Thune (1950) and Hamilton (1950) attempted to show that WU effects are both cummulative and progressive in nature and do dissipate rapidly following termination of the specific activity involved. The Thune (1950) study reported the results of two experiments which attempted to vary both the type and amount of WU activity.

In the first experiment Ss were given three separate tasks. On Day 1 all Ss received an initial practice list followed by a 15 pair paired-associate (PA) list (List A). On Day 2 all subjects again received List A, followed by practice on a second list (List B). Six groups of Ss received either 0, 2, 4, 6, 8 or 10 List A practice trials on Day 1, and 10, 8, 6, 4, 2, or 0 List A practice trials on Day 2, thus holding the total amount of List A practice constant for all groups but varying the temporal relationship between List A practice and List B learning. In addition a 10 minute cartoon sorting task was inserted between Lists A and B on Day 2. Figure 1-1, in Appendix B, and Table 1-1 in Appendix C depict both the design and results for this experiment. These data indicate that as the number of List A trials during Day 2 practice increased, the mean number of correct anticipation on List B also increased demonstrating a WU effect.

While Experiment I assessed WU effects from an associative learning task, Experiment II attempted to assess the effects of WU from a non-associative color guessing task. Since the first experiment involved associative learning both LTL and WU effects would be assumed to transfer to List B practice. Using a color guessing task for List A practice however would result in the transfer of the WU factor alone since List A and List B are highly dissimilar for these Ss. Thune found that practice on the color guessing task produced better List B performance when that practice immediately preceeded List B. These results imply then that the WU component alone was responsible for the NST effects observed in the first experiment.

The experiment reported by Hamilton (1950) was designed to determine the general speed with which WU effects dissipate. With the procedure and materials identical to those used by Thune (1950) the time interval between List A and List B practice on Day 2 was varied from 8 seconds to 240 minutes. The results presented in Figure 1-2 indicate that List B performance declines rapidly at first and then more slowly as the interval between List A and List B increased. The Thune (1950) and Hamilton (1950) experiments taken together support the notion that WU is the primary component of NST and consists of a "set" to respond which develops only gradually over trials.

Thune (1951) has also reported the results of an experiment designed to assess the relative contributions of WU and LTL using three lists of 10 pair adjectives presented on five successive days. A total of 15 different lists were constructed with the relationships between lists minimized. The results presented in Figure 1-3 depict relative large performance gains within each day but much smaller increases between days. Thune argued that since WU effects dissipate rapidly the between Day performance gains represent an assessment of the relative contribution of LTL while the within Day gains in performance result from the progressive built-up of WU.

Contemporary Conceptions of NST: The Learning-to-Learn Hypothesis

Schwenn and Postman (1967) have criticized Thune's (1950) procedure since Ss given the nonassociative color guessing task had experienced a PA task 24 hours previously. If LTL is viewed as a relatively persistent habit then Thune's data resulted from the use of an inappropriate control since these Ss had experienced an associative learning task the previous day. Schwenn and Postman attempted to determine the rates at which NST effects develop by varying the number of first list learning trials. Additionally their procedure made possible the independent assessment of LTL and WU contributions to NST.

Experiment I compared A-B, C-D performance under one of five conditions. Groups LT received a PA task for either 4 or 10 trials. Groups NLT received a number of guessing task in which the physical arrangements and response requirements were similar to those of a PA task, for either 4 or 10 trials. For the NLT groups however no associative learning was required. An additional control group was employed where no first list learning was required. Using 10 pair lists of Haagen (1949) adjectives with a 2:2 ANT rate, Ss were carried to a second-list criterion of one perfect or 10 ANT trials.

From the results depicted in Figure 1-4, it is observed that LT groups did not differ from each other but were significantly different from Group NLT-10 which was equal to control. These differences were significant beginning on Trial 2. While not significant, there are observed differences between the performance of the NLT groups and control. For this reason NLT and control conditions were replicated in Experiment II. Again Group NLT-4 was not different from control; however, performance in the NLT-10 condition was superior to both control and NLT-4 performance.

It should be recalled that LT Ss are transferring both WU and LTL effects while NLT Ss are transferring WU effects only. Schwenn and Postman suggest that NST effects are both larger and develop more rapidly for LT conditions. This implies then that the effects of LTL are the sole contributors to NST early in transfer and that only later in learning are minimal effects of WU observed. This conclusion was reached since Group NLT-4 was never different from control and Group NLT-10, while superior to control was inferior to performance in the LT conditions.

The Schwenn and Postman results and conclusions are the antithesis of those reported by Thune. It should be pointed out however, that a possible interaction between WU and LTL would mitigate the Postman conclusion that LTL is the major component of NST since it is possible that when WU and LTL are both operative (LT groups) NST is enhanced relative to a condition where either WU or LTL is transferred alone.

A common assumption made regarding NST effects is that WU both develops and dissipates at a relatively rapid rate as compared to LTL effects which are usually assumed to develop only later in transfer. Notice the contradiction between this assumption and the interpretation given the Schwenn and Postman data. These authors assumed that WU effects make little contribution to NST. If this is in fact a valid assumption, then an interesting problem arises in that there is good evidence for the rapid dissipation of over-all NST effects, (Newton and Wickens, 1956). Are we to assume then that the over-all diminuation of NST results from the rapid forgetting of LTL habits?

McVaugh and Postman (1969) have argued that specific sources of negative transfer develop in the construction of A-B, C-D lists thus violating the requirements of a C-D control. These sources of negative transfer are thought to result from the use of a limited pool of associatively related or formally similar items in constructing the A-B, C-D lists. The control lists might be more aptly characterized as A'-C, A'-B', or $A'-B'_r$ lists. It should be noted that this is a particularly relevant problem in those situations where more than two lists are employed, e.g., the Thune (1951) experiment.

McVaugh and Postman argue that LTL habits are not rapidly forgotten but rather observed decreases in C-D performance results from specific sources of interference. In addition they suggest that the LTL effect should decline more rapidly between practice sessions when the class of materials in the successive lists remains the same than when it changes. The reason being that with the class of materials constant the item pool is restricted and greater interference is possible during List 2 performance.

McVaugh and Postman tested this prediction. The rationale for the experiment was that any change in the class of materials used to construct List 1 and 2 should greatly reduce if not eliminate item-specific interference which can mitigate the persistant effects of LTL. Using two types of lists A-A (adj.-adj.) or N-L (number-letter) and three levels between training and testings a 3 x 4 factoral design was employed, i.e., groups A-A, A-A; N-L, N-L; A-A, N-L; or N-L, A-A were tested following each of three time intervals, 3 min., 30 min. or 48 hours. In addition two control groups were employed, N-L or A-A with no first list requirements.

From Figure 1-5 a rather marked decrease in performance is observed when the class of materials used in constructing the A-B, C-D lists remains constant. The effect is most apparent at 48 hrs. presumably since WU effects would be expected to maintain performance at the 3 and 30 min. intervals. However, with the dissipation of WU effects negative transfer is observed for groups A-A, A-A and N-L, N-L relative to conditions where the class of materials is different.

McVaugh and Postman conclude that the generally assumed loss of LTL is due primarily to the development of specific sources of negative transfer. If we assume that the definition of LTL is restricted to practice gains reflected in performance on an unrelated second task (C-D) then these data suggest the long term stability of NST from a LTL component. That is, if we compare groups A-A, N-L and N-L, A-A the LTL effects are observed to both develop rapidly and be relatively persistant.

Isolating Specific LTL Transfer Components

The previously cited studies by Postman and Schwartz (1964) and McVaugh and Postman (1969) have indicated that the effects of LTL are observed for subject performance with new form classes of material. In the case where test material remains the same for second list acquisition (Thune, 1950; 1951; Hamilton, 1950) the data would suggest that Ss are in fact learning something about the class of verbal material which can facilitate performance if a short inter-list interval is employed.

Thompson and Fritzler (1968) have suggested that Ss are in fact learning something about the restrictions placed on list construction by the experimenter. These investigators have reported data where the list construction variable was manipulated with bigram-bigram pairs in a PA acquisition task. List S consisted of bigrams where one of the letters represented in the St item was repeated in the response term. List D was constructed with no letter duplication. The hypothesis was that transfer can be facilitated in those conditions where the rule for list construction (either S or D) is constant from first to second list acquisition. Factorially varying the type of list used during acquisition and transfer,four conditions resulted: (1) SS with list S training and transfer, (2) SD with list S training and list D transfer, (3) DS and (4) DD. With the hypothesis of facilitated learning in conditions SS and DD, Ss were tested using 3 x 5 index cards and a 4:4 anticipation rate.

As indicated in Table 1-2, subject performance was not significantly different between conditions SS and DD which were both superior to groups DS and SD which did not differ. These results support the conclusion that when conditions remain constant from acquisition to transfer Ss in fact learn something about list construction which can facilitate transfer performance. As indicated in the results, there was a trend for the superiority of Groups DD as compared to Groups SS. This is somewhat suprising since it would be expected that the development of an appropriate strategy based on list construction would develop more rapidly when specific St letters are duplicated in the response. Thompson and Fritzler however, do not address themselves to this difference.

The above data would seem to indicate that LTL is both a relatively persistent habit and the major source of NST; however, attention has only recently focused on identifying the specific skills which are responsible for the facilitative effects of LTL. One of the earliest experiments to report facilitative LTL effects was by Ward (1937) where Ss learned 16 successive serial lists composed of 12 CVCs, using the anticipation method. Figure 1-6 presents these data. Melton and VonLackum (1941) have reported similar results using a PA task where Ss learned a single list each day for 28 successive days. More recently Keppel, Postman and Zavortink (1968) have reported the results of an extensive experiment which required Ss to learn 36 ten pair word lists at a rate of one list every 48 hours. These data, presented in Figure 1-7 revealed that the facilitative effects of LTL represents a negatively accelerated function which reaches asymptote only after considerable amounts of practice.

While the most typical procedure for investigating LTL has been through the use of unrelated lists (A-B, C-D) Postman (1964) has attempted to isolate paradigm specific LTL effects using four different paradigms either A-B', A-C, A-B_r, or C-D. All Ss learned three sets of two PA lists. The first list of each set was learned to a criterion of seven out of eight correct anticipations, while second list performance was continued for 5 trials. The mean correct responses for these five trials presented in Figure 1-8 indicate improved performance for all four transfer paradigms. These data also suggest that the rate at which performance increases is a function of the particular paradigm involved. Keppel and Postman (1966) have also reported data which indicate that experience with different transfer paradigms has little or no effect on subsequent test list performance. These authors concluded that the important variables seems to involve the specific test list paradigm employed rather than experience with other paradigms or the same paradigm.

Data reported by Postman and Schwartz (1964) and Postman, Keppel and Zacks (1968) have also been concerned with isolating specific LTL mechanisms. In the Postman and Schwartz (1964) experiment both the class of verbal material, either adjectives (A) or trigrams (T), and the type of task, either serial (S) or PA, were varied. Experimental Ss first learned a PA-A, PA-T, S-A or S-T list then transferred to one of four conditions either PA-A, PA-T, S-A or S-T. Two control groups acquired the second PA or S list only. From the data presented in Figure 1-9 and Table 1-3, the authors concluded that the effects of LTL on interlist transfer performance must be largely of a general nature, i.e., independent of the specific method of practice and class of material, since all pretraining conditions produced substantial performance gains. The results do however provide some evidence for method specific LTL effects since performance gains were larger when the method of practice was identical for both practice and test lists. The authors also reported from these data that LTL effects seem independent of the particular form class of materials used. This conclusion was not supported by McVaugh and Postman (1969) or Postman, et. al., (1968).

Using the two-stage model of PA acquisition Postman, Keppel and Zacks (1968) reasoned that several LTL factors can be involved in response learning: (1) Effective distribution of study and rehearsal time, i.e., Ss may learn to first concentrate on response acquisition during early trials and then shift to associative learning. (2) Improved R learning through adopting a serial strategy, e.g., it may be more effective for the subject to learn low meaningful trigrams in a serial fashion. (3) Ss may develop specific skills through the use of menemonic coding devices.

In order to examine the response integration component of LTL Postman, et. al., used a PA task with digit-trigram pairs varying the degree of response meaningfulness (m) in both List 1 and List 2 acquisition. With low m responses it would be expected that specific skills are both developed more fully and are more sensitive to the effects of prior practice. While varying response m from high (H) to low (L) in experimental conditions Postman et. al., used a unique control condition to eliminate WU effects. Control Ss were simply given equivalent practice on a list where response terms were highly available and familiar (i.e., St - digits, R - day of the week). Factorially varying response m during both acquisition and transfer for experimental and yoked controls there were eight possible practice conditions. Using a 2:2 anticipation rate, practice was carried to one perfect trial on List 1 and one perfect or 10 trials on List 2. The results presented in Figure 1-10 and Table 1-4 indicate that: (1) Using trials to criterion as a response measure, List 1 acquisition was more rapid with high m response terms; (2) List 1 response integration occurred more rapidly with high m responses; (3) In terms of performance on early transfer trials there was a significant interaction between experimental and control conditions. If List 1 contained low m responses experimental group performance was superior to that of controls. If List 1 contained high m responses however, experimental Ss demonstrated superior performance only on later trials. This interaction would suggest that more efficient methods of response learning result from practice on low than high m responses, but that practice on either affects subsequent performance relative to a control condition where responses are highly available words.

In terms of over-all transfer the largest differences between experimental and control group performance would be expected in those conditions where first list responses were low in meaningfulness, i.e., either L-H or L-L groups. As observed, this result was in fact present with both trials and mean correct responses yielding significant differences between high vs. low response m and experimental vs. control performance. It would seem safe to conclude from these results that Ss do acquire specific response learning skills in a PA task with low m response items.

Several expeiments have also demonstrated NST effects using the serial learning task (Postman, 1970), three-stage mediation paradigms, and the free-recall learning procedure (Dallett, 1963; Tulving, 1962, 1968; Tulving, McNulty, & Ozier, 1965). Free-recall learning is characterized by the S being permitted to reproduce list items in any order on test trials. Progressive improvements across trials thus becomes a function of the S's ability to group items into higher order units (Postman, 1971). Recently Thompson and Roenker (1971) have postulated an NST learning to cluster variable. With Ss being required to learn three successive lists of categorized words, performance on the first trial of the second list was observed to be equivalent to performance on the terminal trial of the first list, See Figure 1-11.

NST Conclusions

From the available data several general conclusions can be abstracted: (1) While both LTL and WU have been isolated as viable phenomena it would seem that LTL is a relatively persistent habit which is the major contributor to NST effects and that WU effects transfer only following extended practice and dissipate rapidly. (2) It is also apparent that care should be taken in the construction of a NST control (C-D) since specific sources of interference have been identified when material consists of a limited pool of items. This would suggest the possibility of both inflated estimates of positive transfer effects and the under estimation of negative transfer when this source of control group confounding is not eliminated. (3) Regarding the specific components of LTL, Ss seem capable of acquiring "sets" about the structure of lists and specific skills which facilitate response learning when low meaningful material is used. LTL in general however appears to be independent of both the particular paradigm employed and the method of practice.

Methodological Variables

While a number of different problems involving methodological variables such as, absolute versus relative transfer, the use of an appropriate control paradigm and mixed versus unmixed lists, have been investigated, the majority of the research has been concerned with the assessment of performance for comparable paradigms under both mixed list (ML) and unmixed list (UL) conditions. Twedt and Underwood (1959) comparing a number of different transfer paradigms, A-C, C-B, A-B_r, and C-D, found that both the direction and the degree of transfer were identical in the ML and UL conditions with 12 pair, two-syllable adjectives lists, see Figure 2-1. From these data it was concluded that ML or UL designs do not differentially affect transfer performance. It should be noted however that each of the experimental paradigms resulted in negative transfer relative to performance in the C-D control condition.

The conclusion abstracted from the Twedt and Underwood data were drawn into serious question when Johnson and Penny (1965) reported significant performance differences in the A-B_r paradigm between ML and UL conditioning using sixth grade children as Ss. Postman (1966) has suggested that perhaps there exists a LTL component such that the S learns to restrict his responses on the basis of similarity relationships between successive lists. For example, in the A-B' paradigm the S could learn that he is encountering identical stimuli and further that his performance can be optimized by responding with associates of the List 1 response. In this instance the S would transfer an effective mediator (A-B-B'). In the A-C paradigm the S may in fact learn to actively inhibit or avoid previously correct responses. Postman proposes a response restriction rule which would imply that ML versus UL performance will be differential to the extent that the ML S is forced to apply multiple list rules rather than a single list rule to optimize his performance. For the ML S then the attempted use of a response restriction strategy could in fact result in interference rather than facilitation.

Postman points out that since all conditions utilized in the Twedt and Underwood experiment resulted in negative transfer then it is conceivable that in such a paradigm rules of restriction are more difficult to apply than they are in the typical positive transfer situation. For example, response suppression in A-C may be more difficult than the learning of appropriate associates in the A-B' paradigm. To test this prediction Postman compared ML and UL performance on each of four transfer conditions, A-B', A-C, C-B or C-D. Using two lists of 12 pair adjectives with a 2:2 anticipation rate no significant differences were found on first list performance. In terms of the percent of relative transfer on the first List 2 trial no difference was observed between ML and UL performance in the A-C paradigm but large differences are observed between these groups in the positive transfer paradigms C-B and A-B'. The overall transfer effects are depicted in Figure 2-2 and Table 2-1.

Regarding performance in the A-B' conditions Postman observed that the UL Ss are consistently superior: however, these differences are small, the response restriction rule being supported by significant differences only on the early transfer trials. Further, analyses across trials for the C-B and A-C conditions indicated that Ss in ML conditions did attempt the application of a response restruction rule which resulted in significant interference relative to its application in UL conditions. The lack of difference between UL and ML groups in the C-D condition was also interpreted by Postman as support for the notion of a response restriction rule being employed in other paradigms since there is no obvious strategy which could develop in this control condition.

Slameka (1967) using a similar logic hypothesized that UL and ML differences would result in A-B, A-Antonym and A-B, A-Synonym conditions since a single strategy can be employed in the UL condition. Using a 2:8 rate to provide the opportunity for a mediational strategy to develop Slameka tested Ss under the conditions, A-Ant, A-Syn, A-B, A-B_r and C-D with 20 pair lists of high m CVC stimulus items and adjective responses, using a study-test procedure.

The results indicated significantly better performance in the A-Syn and A-Ant conditions. Differences between UL and ML groups were absent in all experimental paradigms. While these results are discrepant with those reported by Postman the possibility remains that the use of an 8 sec. feedback interval allowed the Ss to effect multiple strategies within a list. In addition Postman (1971) has observed that these data are difficult to interpret since trigram stimuli were used in successive 20 pair lists resulting in possible interference effects in the control condition (C-D). Slamecks's data revealed a lack of negative transfer in the A-B_r UL condition, consistent with Postman's criticism.

Wickens and Cermak (1967) have reported the results of two experiments which support Postman's conclusion that the use of a mediator is possible when the transfer paradigm utilizes the identical stimuli but new responses and that this would not only mitigate the generally predicted negative transfer but also facilitate performance differentially in UL and ML conditions. Using four paradigms (C-D, A-C, A-Ant and A-Syn) Wickens and Cermak predicted an interaction between lists and designs (UL vs ML). With numbers as stimuli and adjective responses a 2:2 anticipation rate was used. Experiment I used one perfect trial as a first list criterion while Experiment II used two consecutive errorless trials as a criterion.

As observed from Figure 2-2 marked performance differences were observed between UL and ML groups for the A-Ant condition as compared to both the A-Syn and A-C conditions. This would suggest that the mediational strategies appropriate for A-Syn and A-Ant pairs are competing in ML conditions and further that the A-Syn strategy results in somewhat greater interference for A-Ant pairs. Wickens and Cermak conclude that at least for paradigms where a mediational strategy is possible within the framework of identical stimuli but new responses performance is affected by the list structure.

From the reviewed studies the following conclusions have been supported: (1) When stimuli remain identical but responses very, mediational processes are involved in certain paradigms and differentially affect UL and ML conditions with performance being enhanced in an unmixed list and to some degree inhibited in a mixed list condition, (2) In those paradigms where a mediational strategy is not as readily appropriate, e. g., A-C and C-B, mixed list performance would seem to be inferior relative to an unmixed-list condition since interference is generated when multiple strategies are required simultaneously.

Specific Transfer Effects: The Identification of Phenomena

Specific transfer effects result from similarity relationships between tasks. With verbal materials these effects are defined in terms of stimulus and response similarity. Early experiments by Muller and Schumann (1894), who formulated the law of associative inhibition, Wylie (1919) and Poeffenberger (1915) have all demonstrated the utility of adopting a stimulus-response model for the systematic investigation of specific transfer effects. In particular the experiments reported by Poffenberger (1915) led to the proposal of three general laws of specific transfer: (1) Positive transfer results when the stimulus and response remain identical, (2) Negative transfer results when the stimulus remains identical but the response changes and (3) Zero transfer results when both the stimulus and response change, (Postman, 1971).

Bruce, (1933), varying both St and R similarity in nine different paradigms, subjected Poffenberger's transfer postulates to a systematic test using CVC materials. In addition a fourth postulate proposed by Wylie (1919), that positive transfer will result when the response remains identical and the stimulus changes, was tested. While these four transfer postulates were supported, the design contained several inherent deficiencies, e.g., the paradigm manipulation occurred in the second-list, which prohibits generalization; however, the study does represent one of the first attempts to investigate specific transfer effects via paradigmatic variations in successive list components.

The utility of paradigmatic research to test theoretical predictions is brought into sharp focus by Gibson's analysis of stimulus similarity as a critical variable in transfer.

Stimulus Similarity: Gibson's Hypothesis

Gibson (1940) has offered the postulate that both generalization among stimuli and differentiation between stimuli represent the crucial variables in the transfer learning task. More specifically Gibson has hypothesized that a reduction in the tendency to generalize, i.e., learning to differentiate between stimuli, is the bais for second task acquisition and results from the nonreinforcement of the generalized responses.

Earlier experiments reported by Yum (1931) had demonstrated the importance of both formal and meaningful similarity to stimulus generalization in an associative learning task. As mentioned, Gibson made the assumption that the greater the degree of generalization between successive list stimuli the more difficult the differentiation process becomes in transfer. Additionally, she postulated that generalization tendencies would show spontaneous recovery effects since differentiation was assumed to dissipate over time. Gibson's hypothesis then represents an attempt to apply traditional principles of learning, involving conditioned stimuli and responses to the verbal learning task.

Specific predictions from Gibson's hypothesis were tested by Gibson (1941) and Hamilton (1943) using configurational stimuli (see Figure 3-1) that represented varying degrees of formal similarity. With the prediction that the direction of transfer is determined by either identical or different responses and the magnitude of transfer is determined by the degree of generalization (formal similarity between successive list stimuli) two separate experiments were conducted. In the first Gibson (1941) found negative transfer with different second list responses to be an irregular increasing function of stimulus generalization. The second experiment reported by Hamilton (1943) revealed that increased stimulus generalization results in increasing positive transfer with identical second list responses. As Postman (1971) has pointed out all that can be concluded from these data is that the direction of transfer is determined by response similarity while the magnitude of transfer represents some increasing function of stimulus similarity since the prediction of a regular transfer gradient was not supported. Both Bugelski and Cadwallader (1956) and Dallet (1962) have also failed to support the stimulus generalization hypothesis using different second list responses, i.e., negative transfer paradigms.

Underwood (1961) has criticized the Gibson hypothesis from both methodological and theoretical perspectives. First, the configurational stimuli used in these experiments were derived from normative data obtained in a study-test procedure. Any experiment using these stimuli then represents a validation of the normative test itself rather than a test of interstimulus generalization effects in transfer. Secondly, the Gibson hypothesis was both developed and tested using the concept of sensory generalization, configurational stimuli. As a result it has little to say regarding stimulus generalization effects with nonsensory stimuli, verbal material. Perhaps most importantly the hypothesis fails to consider the effects of response generalization on both the direction and degree of transfer. The problem of predicting response generalization effects was effectively resolved in a historically significant contribution made by Osgood (1946, 1948, 1949).

Response Similarity: Osgood's Net Transfer Surface

The work of C. E. Osgood came to fruition in a 1949 Psychological Review paper which made two important contributions to the study of specific transfer effects: (1) It suggested a model for meaningful similarity and focused attention on its relationship to the direction and degree of transfer, (2) The model proposed three empirical laws to account for transfer phenomena.

From the surface depicted in Figure 3-2 if S_I remains constant and R is varied from R_I to R_A the surface predicts an initial rapid decrease in positive transfer and subsequent increasing negative transfer, e.g., (A-B, A-B varied to A-B, A-C to A-B, A-Ant). This then is Osgood's first law of transfer. When stimuli are identical and interlist response similarity is varied, the amount of negative transfer will decrease as response similarity increases.

Osgood's second law predicts that positive transfer will increase from zero (C-B or S_N-R_I) to maximal positive transfer (A-B or S_I-R_I) as interlist stimulus similarity increases. When responses are identical and the interlist stimulus similarity is varied, positive transfer will increase as stimulus similarity increases.

The third law of transfer predicts that, when both interlist stimulus and response similarity are varied simultaneously, negative transfer will increase as the stimulus similarity increases. It should be noted from the transfer surface that increasing negative transfer must be predicted when interlist response similarity is held constant, either at R_{ANT} or R_N, and interlist stimulus similarity is varied, (A-B, C-D varied to A-B, A-C). While this prediction is not directly stated by Osgood it is definitely implied from the net transfer surface.

Direct attempts to validate Osgood's net transfer surface have produced mixed results. Dallett (1962) has reported data which are in essential agreement with Osgood's surface; however, Bugelski and Cadwallader (1956) and Wimer (1964) have failed to support several of these paradigmatic predictions.

Hall (1971) has presented an excellent comparison between the Bugelski and Cadwallader (1956) data and Osgood's theoretical predictions, (see Figure 3-3). Using Gibson's nonsense configurations as stimuli and familiar words as responses 16 different transfer paradigms were tested. The transfer task consisted of four levels of stimulus similarity varying from identical to neutral and four different response conditions varying from identical to opposed. Procedurally two consecutive correct responses to a given pair resulted in it being removed from the list. It should also be noted that the specific paradigmatic manipulation occurred in the transfer list rather than in the acquisition list as is the more proper practice. The results indicate close agreement between predicted and observed transfer performance only when R was held constant at either identity, similarity, neutrality or opposition, and St was varied from identity to neutrality (Law 2). The most marked discrepancies resulted in the R similarity and opposed conditions. With St held constant and R varied,however. predicted and observed differences appear for each of the four St conditions. This lack of support for Osgood's first law has also been reported by Wimer (1964).

Wimer factorially varied five degrees of stimulus and response similarity using Osgood's original material to both test and extend the net transfer surface. Table 3-1 presents Wimer's data.

For each of the empirical laws posited by Osgood, support was minimal when stimulus relationships were held constant and response similarity varied, (Law 1) and maximal with response similarity constant and stimulus similarity varied, (Law 2). This is primarily due to the inclusion of R_S and R_A conditions. If on the other hand the net surface is depicted with responses varying only from identity to neutrality the data were in approximate accord with Osgood's predictions, with the only significant deviation resulting in paradigm A'-B', (Law 3).

In general, the net surface proposed by Osgood would seem to be of considerable theoretical utility when S_1-S_2 and R_1-R_2 relationships are varied from identity to neutrality. This prediction has also been supported from data reported by Morgan and Underwood (1950), Underwood (1951) and Young (1955). It should be noted however, that the net surface is predictive only for the identification of gross or over-all transfer effects within a particular paradigm. The interaction with secondary variables would be expected to differentially affect performance resulting in considerable variance. This problem has been addressed in a component process model of transfer proposed by Martin (1965).

Underwood (1951) has proposed an intriguing account of response similarity effects which incorporates a concept of parasitic reinforcements. This conceptualization of reinforced practice assumes that reinforcement functions to strengthen not only the A-B association but also the association between A and any other response which is similar to B, e.g., B' or B". The hypothesis is thus one of generalized associative strength, the gradient of which is determined by the similarity between responses. The parasitic reinforcement hypothesis makes the specific prediction that second list associations, A-B' or A-B", are strengthened as a function of the degree of first list practice. Stated differently, positive transfer with response similarity and stimulus identity is predicted to be an increasing function of the degree of first list practice. Underwood's data, presented in Figure 3-4, support these predictions with three degrees of first list learning and three levels of response similarity. We shall return to this concept of parasitic reinforcement later when mechanisms of transfer in the A-B' paradigm are considered.

Martin's Component Process Model

Martin's conception of transfer components is based on the assumption that PA acquisition consists of both response and associative learning. Incorporating the concept of associative directionality there are in Martin's view three components which evolve during PA acquisition: (1) Response Availability (R), (2) Forward Associations (F), and (3) Backward Associations (B). The primary thesis of the model is that what is transferred is some combination of these effects. Rather than employing a net transfer surface, Martin argues that an accurate depiction of transfer must involve three surfaces describing how a particular effect is transferred as a function of its position within the coordinate system of a particular surface as depicted in Figure 3-5.

Within the R surface it is assumed that learning transfers maximally where first list and transfer task responses are identical. That is, with response identity constant and stimulus similarity varied from neutrality to identity (C to A) transfer will be maximally positive. As response identity decreases (C-B to C-D and A-B to A-C) positive transfer is thought to decrease from positive to zero. Notice that first list response learning in Martin's conception can only contribute positively to second list acquisition.

Within the F surface the predictions made regarding transfer performance are essentially the same as those provided by the Osgood surface. Forward associative learning (FA) is assumed to contribute to transfer when the second list stimuli can elicit the first list responses. The F surface then is dependent on the degree of similarity between first and second list stimuli (S_1-S_2 relationships). When second list responses are similar to those present during first list acquisition the elicition of B will facilitate performance. This effect will be maximal when first and second list responses are identical (A-B). With R_1-R_2 similarity constant at identity the amount of positive transfer resulting from FA will decrease as S_1-S_2 similarity decreases from ideneity (A-B) to neutrality (C-B). With S_1-S_2 similarity constant at identity and the degree of R_1-R_2 similarity varied, transfer will initially be a decreasing positive function (A-B to A-B') and subsequently an increasing negative function (A-B' to A-C) since FA would result in response competition when R_1 and R_2 are dissimilar (A-C).

As previously indicated the component process model makes a directionality assumption i.e., it is assumed that St-R learning is symmetric to R-St learning. For this reason it is necessary that the transfer model incorporate a surface depicting the effects of backward associative learning (BA) within the defined coordinate system. While the described F surface was dependent on the degree of similarity between stimuli, the B surface is symmetrically dependent on the similarity between first and second list responses (R_1-R_2). With stimulis identity constant and response similarity varied the predicted function is decreasing positive transfer since the probability of R_2 eliciting S_1 decreases as second list responses become more dissimilar to those learned during first list acquisition. In a similar manner with the R_1-R_2 relationship at identity, varying the degree of similarity between S_1-S_2 (A-B to C-B) results in an initial decreasing positive function from A-B to A'-B and a subsequent increasing negative transfer function with increasing S_1-S_2 dissimilarity as A'-B varies to C-B.

In terms of predicted net transfer effects for each of the major transfer paradigms the exact position within each of the three coordinate systems is thought to be a function of secondary variables, such as degree of list one learning and response meaningfulness (See page 131). Using Martin's conception regarding component processes in transfer, specific predictions regarding net transfer effects are possible, as depicted in Table 5-1.

The basic advantage of Martin's model then is a refinement of predictions which function to account for many disparite experimental results. For example, in the C-B paradigm, reported results have varied from obtained positive to negative transfer relative to C-D learning (see page 136). While Osgood's surface predicts zero transfer for C-B acquisition the Martin model suggests an interaction with secondary variables which can differentially affect the relative importance of R, F, or B transfer suggesting that second list performance can be either positive, negative or equal to that observed for C-D Ss.

Dallett's Repaired Transfer Surface

As Martin (1965) points out any transfer surface has considerable difficulty accounting for the relatively massive negative transfer usually observed in the A-B_r transfer paradigm. This paradigm is characterized by identical S_1-S_2 and R_1-R_2 relationships. Using traditional transfer surface coordinate systems then would define A-B_r transfer as a high positive paradigm identical to A-B. The difference between these two paradigms is of course a noncorresponding relationship between first and second list stimulus and response pairings for the A-B_r condition. This repairing functions to introduce both FA and BA interference rather than facilitation as is true with the A-B paradigm. Dallett (1965) has described and presented data for an A-B_r transfer surface in Figure 3-6.

Using the Gibson geometric figures as stimuli and response adjectives, Dallet tested the transfer paradigms, A-B, A'-B, A-B', C-B, A-C, C-D, A-B_r, A'-B_r, A-B'_r, and A'-B'_r. Using the C-D control for relative comparisons the mean correct responses on total trials support predictions from the transfer surface. Conditions A-B and A'-B both gave significant positive transfer while conditions A-B_r and A-B'_r were both significantly inferior. The most marked deviations from predicted performance occurred with the A'-B and A-C paradigms. The A'-B paradigm while usually positive was not significantly different from A-B transfer performance. The A-C condition while expected to yield negative transfer was not different from that of C-D Ss. It would seem probable that the use of the relatively difficult Gibson figures as stimuli resulted in the transfer of a large positive stimulus differentiation component as compared to C-D, which functioned to mitigate associative interference in the A-C paradigm.

A Generalization Surface for the Simultaneous Variation of St and R Similarity

Shea (1969) has described a solely positive transfer surface for paradigms ranging in similarity from A-B to A''-B''. The primary purpose of the reported experiment was to test predictions regarding the probability of simultaneous generalization. Basically, Underwood (1961) predicts a function $P_{A'} x P_{B'} = G$ where $P_{A'}$ is the probability of stimulus generalization, $P_{B'}$ is the probability of response generalization and G is the probability of a simultaneous generalization. Shea's design included the paradigms A-B, A-B', A-B'', A''-B, A'-B, A'-B', A'-B'', A''-B' and A''-B''. These latter four paradigms provide direct tests of Underwood's predictions since both stimulus and response similarity are varied simultaneously. Using nine pairs of Haagen adjectives during a first list PA task, the second task involved a multiple choice recognition test. For example, with the paradigm A-B, A'-B' a first list pair might be ANGRY - LITTLE. The multiple choice test employed during the second task then might be ENRAGED. 1. CENTRAL; 2. PETITE; 3. HEAVY. The S being required to recognize which of the three alternatives was similar to the first list response LITTLE. The PA task employed the study-test method with a 3 sec. rate and was carried to a criterion of 3 successive perfect trials. Experiment II employed an identical procedure with new St and R material.

In Figure 3-7 Shea's transfer surface depicts the percentage of correct response identifications during the multiple choice test, for both experiments. Several important effects are observed from this surface: First, there seems to be a strong effect for both stimulus and response similarity with the stimulus gradient being somewhat steeper. Second, Ss did in fact exhibit transfer of first list associations to a second task involving, in the simultaneous case, both new stimuli and responses. Notice that this transfer occurred without the aid of learning trials, i.e., no feedback was given during the multiple choice test. Third, decreased stimulus and response similarity did result in an increasing performance decrement.

The $P_{A'} xP_{B'}=G$ prediction was examined by using the observed relative frequencies of choice in the A-B', A-B'', A'-B, and A''-B conditions to predict relative frequencies for the simultaneous conditions. Using a x^2 analysis, differences between predicted and observed frequencies (See Table 3-2) were nonsignificant except for the A'-B'' condition in the first experiment.

Shea observed that the asymmetry between the stimulus and response dissimilarity gradients (i.e., a relatively steeper stimulus gradient) was not predicted. While it is possible that this gradient difference resulted from more complete response learning during the

PA task Shea suggested that the nature of the multiple choice task itself produced the observed difference, since appropriate response identification was measured via a recognition task and stimulus identification via appropriate recall of the first list. For example, with the pair ANGRY - LITTLE appropriate second task performance could result only when the previous stimulus ANGRY was elicited by the A' stimulus ENRAGE. Contrast this with the requirement for appropriate response identification. With the PA pair ANGRY - LITTLE appropriate second task performance is dependent only upon the recognition of a previous response or its associate. It is not necessary that the second task response elicit the first list stimulus, only that it be recognized. Shea reports data from a third experiment which utilized a free-recall second task. Under this condition the observed stimulus and response dissimilarity gradients were symmetric.

Variations In S_1-R_2, S_2-R_1 Similarity

While the paradigmatic manipulations thus far considered have involved the meaningful similarity between S_1-S_2 and R_1-R_2 the Houston (1964) backward surface describes second list transfer in terms of S_1-R_2 and S_2-R_1 similarity. The four basic paradigms generated within this framework are C-D, C-A, B-C, and B-A. Essentially, the Houston surface simply involves a re-labeling of Osgood's surface in accord with the defined S_1-R_2 and S_2-R_1 relationships as represented in Figure 3-8.

Considering the similarity between first list stimuli and second list responses and the similarity between second list stimuli and first list responses, Houston (1964) points out that the derived transfer surface makes seveal specific predictions: (1) If the first list responses are neutral with respect to second list stimuli (S_2-R_1 axis) then regardless of the degree of S_1-R_2 similarity transfer will be minimal, i.e., with C-A varied to C-D no differential transfer predictions are made. (2) If second list responses are neutral with respect to first list stimuli (S_1-R_2 axis) then as S_2-R_1 similarity increases negative transfer will increase, i.e., with C-D varied to B-C increasing negative transfer is predicted. (3) If first list stimuli are identical to second list responses (S_1-R_2 axis) then as S_2-R_1 similarity increases positive transfer increases, i.e., with C-A varied towards B-A increasing positive transfer is predicted. (4) If second list stimuli are identical to first list responses (S_2-R_1 axis) then as S_1-R_2 similarity increases transfer increases from maximal negative (B-C) to maximal positive at (B-A). Houston reports that Murdock (1956 and 1958) found high positive transfer with the B-A paradigm relative to a C-D control and high negative transfer with the B-C paradigm, as predicted by the net transfer surface described.

Houston (1966a) has reported data for the paradigms, B-A, B'-A, C-A, B-A', B'-A', C-A', B-C, B'-C, and C-D which offer strong support for the transfer surface. Using 8 pair lists of common Haagen adjectives with a 2:2 anticipation rate <u>S</u>s were given six transfer trials. The mean correct responses on the first transfer trial are presented in Table 3-3. It is observed that the paradigms B-A, B'-A and B-C are all significantly different from C-D. For those paradigms where zero net transfer was predicted, (C-A, C-A', B-A', and B'-A') nonsignificant differences were obtained. However, in terms of total correct anticipations the means were 45.13, 35.38, 28.75 and 27.5 for the paradigms B-A, C-D, C-A, and B-C respectively. These data then offer some support for the conception of transfer predicted by variations in S_1-R_2 and S_2-R_1 similarity.

Houston (1966b) has also reported data regarding the hypothesis that with S_2-R_1 similarity identical, transfer increases from maximal negative to maximal positive with increasing S_1-R_2 similarity. Using Haagen adjectives to construct the paradigms, B-A, B-A', B-A_2, B-A_3, B-A_4 and B-C (increasing subscripts represent decreasing S_1-R_2 similarity) with a 2:2 anticipation rate for six transfer trials the results depicted in Figure 3-9 conform closely to those predicted by the net transfer surface. With mean correct responses the only observed significant differences involved comparisons between B-A, B-C and C-D, with B-A being superior and B-C inferior to C-D.

A Repaired S_1-R_2 and S_2-R_1 Surface

Following the logic outlined by Dallett (1965), Houston (1965) has described a repaired transfer surface for the S_1-R_2, S_2-R_1 paradigms, see Figure 3-10. As was true for the nonrepaired surface when S_2-R_1 similarity is minimal transfer will be minimal but as S_2-R_1 similarity increases transfer increases, negatively when S_1-R_2 similarity is neutral and positively when S_1-R_2 similarity is maximal.

With the repaired paradigms, increases in S_1-R_2 similarity, holding S_2-R_1 similarity constant at identity, results in increasing negative transfer (B-C varied to B-A_r). In a like manner increasing S_2-R_1 similarity with S_1-R_2 similarity constant at identity results in increasing negative transfer (C-A varied to B-A_r). Houston notes as does Dallett that the associative learning which occurred during original A-B acquisition is the probable mechanism which produces the relatively massive negative transfer observed in the repaired paradigms.

Houston and Morony (1966) have presented data testing predictions from the repaired surface using the paradigms B-A_r, B'-A_r, B-A'_r, B-C and C-D, with 8 pair lists of Haagen adjectives. In terms of correct responses all groups were found to be significantly different from the C-D control with B-A_r=20.40, B'-A_r=18.75, B-A'_r=21.65, B-C=21.2 and C-D=29.20. While in general the predicted negative transfer for each of the repaired paradigms was observed there was a marked lack of difference between the groups B-A_r, B'-A_r, B-A'_r and B-C which was not predicted.

Shouldis (1968) postulated that the reason for the failure to observe predicted differences in the Houston and Morony experiment was the use of a between-groups design which could have produced large amount of variance functioning to mask the relatively small differences predicted by the net transfer surface. For this reason, Shouldis employed a mixed-list design with 12 pair Haagen adjectives and the paradigms C-D, B-A_r, B'-A_r and B-A'_r. The results indicated correct response means of 10.67, 4.67, 6.60 and 6.47 for each of the above conditions respectively. Significance tests indicated differences between each of the repaired conditions and control performance. In addition B-A_r was found to be significantly inferior to both the B'-A_r and the B-A'_r conditions which did not differ from each other. These results then conform exactly to those predicted by the original repaired transfer surface. They should however, be evaluated with considerable caution since the introduction of the mixed-list procedure itself could be affecting specific paradigm performance differentially.

Mechanism of Transfer in the S_1-S_2 and R_1-R_2 Paradigms

The impact of Martin's component process analysis of transfer has been tremendous. Any attempt to isolate specific transfer mechanisms is therefore necessarily concerned with defining the component processes within a specific paradigm and determining their interaction with relevant secondary variables. In addition, the component process approach has drawn into sharp focus the importance of distinguishing between response and associative learning stages in PA acquisition. A recent study by Postman and Stark (1969) illustrates this point.

Using single letters stimuli and adjectives as responses with the study-test method, *S*s were required to learn two lists using either the PA recall task, where both associative and response learning factors would be expected to affect transfer perofrmance or a multiple-choice recognition task, where the effects of response learning would be minimized and transfer performance would reflect the influence of associative factors alone. Testing the traditional paradigms, C-D, C-B, A-C, A-B_r and A-B' the results in Figure 4-1 are supportive of Osgood's net transfer surface with A-B' being slightly positive, A-C and A-B_r negative, and C-B zero relative to C-D, when the recall method was used. However, when the multiple-choice method was used all paradigms were negative relative to C-D. As Postman (1971) states, "...these findings call attention to the fact that a precise analysis of transfer into its components depends on the development of methods of measurement that are differentially sensitive to the several constituent processes, (p. 1066)."

A-C Transfer

Kausler (1966) characterizes A-C transfer as the to B or not to B paradigm, since the major and most easily identified source of transfer is forward associative interference (FAI). Martin (1965) also considers FAI as the primary component of transfer in the A-C paradigm. However, it should be noted that a positive component is also transferred as a function of intralist stimulus differentiation, i.e., the elimination of generalization tendencies within the list. Thus relative to C-D Ss who must differentiate new stimuli, A-C Ss should transfer a positive component from A-B acquisition. This transfer component from stimulus differentiation while usually assumed to function is thought to be relatively weak since A-C transfer is usually negative relative to both C-B and C-D (Hall, 1971). Considering Martin's (1965) conceptualization of net transfer effects in terms of component processes, research in recent years has turned to the identification of relevant secondary variables using the A-C paradigm as a vehicle to this end. (Jung, 1963; Goulet, 1965; Richardson and Brown, 1966). Attention to these data however will be deferred to a later section of the paper.

Associative Interference. As Hall (1971) points out the A-C paradigm has long been recognized as an appropriate paradigm to study FAI. In fact Muller and Schumann (1894) postulated a law of associative inhibition which asserted that when any two terms become associated it is more difficult to form a new association for either term. This of course would apply equally to transfer in the C-B paradigm. Almost all investigations subsequent to that of Muller and Schumann have verified that FAI is a potent source of transfer. Recently, Twedt and Underwood (1959), see Figure 2-1, and Postman (1962), see Figure 4-2, have also shown the A-C paradigm to produce substantial amounts of negative transfer when contrasted to performance in both C-D and C-B paradigms.

Postulating that FAI is the mechanism producing negative transfer in the A-C paradigm leads naturally to the speculation that first list A-B associations must be unlearned before second list A-C associations can be accomplished. The notion of A-B unlearning has received strong support from data reported by Barnes and Underwood (1959), see Figure 4-3, who found that first list responses become increasingly less available to recall as A-C learning progressed. Popp and Voss (1965), however, have reported data from a probability learning experiment which used a procedure where A-B and A-C practice was alternated over blocks of 1, 5, 10, or 20 trials with all groups receiving a total of 40 trials. The results indicated that FAI is enhanced as a function of shifts between lists, since the A-B associations are maintained. All groups however did acquire both the A-B and the A-C lists. Jung (1970) has pointed out that this result is not predicted from the A-B unlearning hypothesis.

Jung (1970) attempted to answer the question, is A-B unlearning a prerequisite for A-C learning or merely the result of A-C learning? To accomplish this Jung obtained data under conditions which prevented the unlearning of A-B first list associations. Following the achievement of criterion performance on an A-B list (6/9 correct anticipations) a second list, either A-C or C-D, was introduced and alternated with the A-B list for six trials each. The procedure used nine pair lists of nonsense syllable stimuli and response adjectives with a 1.5:1.5 rate. Regarding performance on the A-C list, which was identical for all groups, the mean number of correct responses were not significantly different, with 33.5 and 36.0 for A-C and C-D Ss respectively. The results for the transfer lists however, did indicate the typical negative transfer for A-C with 10.2 correct responses as compared to 24.7 for C-D Ss. Jung concluded that A-B unlearning is not a necessary condition for A-C acquisition. With continued practice Ss are capable of discriminating between list requirements of different responses to identical stimuli. It does seem probable however, that the prevention of A-B unlearning enhanced the negative transfer observed during A-C acquisition, in line with the results of the Popp and Voss (1965) experiment. Similar results were also reported by Garskof (1967) and Popp (1971). Garskof tested for the availability of first list responses following A-C acquisition by requiring Ss to identify first list responses embedded in a set of six synonyms. No identification errors were made.

Using a procedure similar to that of Jung (1970) to investigate the component of associative interference in various transfer paradigms Crouse (1968) has presented data which suggests that the strength of FAI is equivalent in the A-C and $A\text{-}B_r$ paradigms. Employing the paradigms C-D, C-B, A-B', A-C, A-B_r and A-B; first and second list practice was alternated every two trials from the beginning of training. Each list consisted of 10 pairs with low frequency three letter words as stimuli and Haagen (1949) adjectives as responses. The Ss were also completely instructed regarding the change between lists. Practice was carried to 20 trials for each list.

As observed from Figure 4-4, acquisition of the A-B list which was identical for all groups, both A-C and A-B_r were significantly inferior to C-D, which was not different from A-B' or C-B. Crouse also provides estimates of the strength of FAI in both the A-C and A-B_r paradigms. Using mean differences scores it can be seen from Table 4-1, that FAI in the A-C and A-B_r paradigms is approximately equal. The mean differences in terms of correct responses between C-D and A-C Ss was 27.0 while the mean differences between C-B and A-B_r Ss was 25.35. It should be noted that the difference between A-C and C-D represents a positive component from stimulus differentiation in addition to the negative FAI component. Comparing C-B with A-B_r also results in an estimate of stimulus differentiation and FAI since the positive response learning component and the negative component from BAI are both present in C-B transfer and thus subtracted out in obtaining a difference score between C-B and A-B_r. In a like manner estimates of BAI can be derived for both the C-B and A-B_r paradigms. From these results the estimates are, 18.15 for C-B, using the difference in scores between C-D and C-B, and 16.50 for A-B_r, which is estimated by obtaining the difference in scores between groups A-C and A-B_r, thus subtracting out the transfer components of stimulus differentiation and FAI which are present in both paradigms. The accuracy of these estimates can be checked by computing the sum of the estimated associative interference in A-B_r using the C-B, A-B_r estimate of FAI (25.35) and the A-C, A-B_r estimates of FAI (16.50) and comparing this sum (41.85) with a net estimate of transfer in A-B_r, i.e., the C-D, A-B_r differences score which is equal to 43.50. As observed these estimates appear comparable. The important implications for a discussion of associative interference in the A-C paradigm are: (1) that FAI in A-C is approximately equal to that observed in A-B_r, and (2) that the strength of FAI in A-C appears to be greater than the FAI observed in either C-B or A-B_r.

Goulet and Behar (1966) have utilized quite a different procedure for investigating the role of associative interference in transfer. This experiment reported data for A-C and C-B performance under conditions where Ss had either unidirectional (A-B) practice or bidirectional (both A-B and B-A) practice during first list acquisition. The assumption was made that FAI is greater than BAI as a function of the particular acquisition method and further that if R-St and St-R were equated, equal negative transfer would be expected for A-C and C-B paradigms when response learning transfer is minimized, i.e., bidirectional practice should affect C-B performance but not A-C.

To minimize response learning as a positive transfer component high meaningful Haagen adjectives were used. Using eight pair A-B lists, list two contained either four C-B and four C-D pairs or four A-C and four C-D pairs. Bidirectional practice was randomized such that each pair was presented an equal number of times in both A-B and B-A positions. Following 10 transfer trials Ss were given a modified free recall (MFR) test. B-A recall was tested for C-B Ss, as was A-B recall for A-C Ss. These data are presented in Table 4-2.

In terms of second list performance the data were transformed using E-C/E+Cx100 measure. As predicted bidirectional first list practice significantly increased the amount of negative transfer for C-B Ss. The more relevant observation here however, is the significant reduction in negative transfer for A-C Ss following bidirectional practice. It is possible that B-A practice for these Ss reduced the strength of the A-B association and thus the amount of observed interference during second list practice. This conclusion however, is not supported from the MFR data, since bidirectional practice did not affect A-B recall. The mean number of responses recalled was 3.19 for A-C Ss following unidirectional practice as compared to 3.12 for Ss who received bidirectional practice.

These results are further complicated from data reported by Stetten (1970). Stetten replicated the Goulet and Behar experiment and reported increased negative transfer following bidirectional practice for C-B Ss, however, the reduction in amount of negative transfer for A-C Ss was not observed. Unfortunately the resolution of these conflicting data must await further research.

Stimulus Differentiation. As mentioned, A-C transfer is generally observed to be negative relative to C-D as a result of FAI: however, intralist stimulus differentiation does represent a potential source of positive transfer since the interlist stimuli maintain an identity relationship for A-C Ss while C-D Ss must differentiate new second list stimuli. Several investigations (Arnoult, 1957) have attempted to isolate this positive transfer component using a stimulus pre-differentiation technique to enhance the discriminability of configurational stumuli which are associated with particular labeling responses. As Postman (1971) has indicated the pre-differentiation research has achieved only limited success and offers little to an understanding of component processes in A-C transfer.

Underwood and his associates have in a series of experiments investigated the assumed positive transfer component of stimulus differentiation in the A-C paradigm using verbal materials. Underwood and Ekstrand (1968) point out that if interstimulus similarity is low then second list differentiation is not difficult for C-D Ss and the positive component assessed for A-C Ss is minimal; however, if interstimulus similarity is high C-D Ss must differentiate new stimuli and A-C Ss will transfer a relatively large positive component. Using two levels of similarity (low and high, LS and HS) and two paradigms (A-C and C-D), Underwood and Ekstrand report the results of three experiments which differed only in the type of materials and the first list criterion. With six pair lists the stimuli were consonant trigrams and the responses were common three letter words. In the LS conditions 18 different consonants were used while in the HS conditions only 5 different consonants made up the six stimuli.

Across experiments the HS lists were observed to be significantly more difficult (LS=11.29 trials, HS=33.52 trials) than LS lists. Regarding transfer performance, two response measures were used, either total correct responses or correct responses on trials 1 and 2. As observed from Figure 4-5 the predicted interaction was obtained in only one of six analyses using correct responses on trials 1 and 2 with three consecutive perfect trials as a first list criterion.

Underwood and Ekstrand concluded that either: (1) transfer resulting from stimulus differentiation is minimal or (2) other factors associated with high similarity function to mitigate the positive transfer effect, e.g., it is possible that FAI is greater in the HS condition. This latter alternative would seem more plausible since first list practice differences were dramatically different for HS and LS lists. Also Goulet and Behar (1966) found reduced negative transfer when FAI was made weaker by B-A practice. It would seem then that one way to circumvent this problem would be to yoke control LS and HS subjects such that the degree of list one practice is equated.

Similar results have been reported by Saravo and Price (1967) using sixth grade children and three levels of stimulus similarity. LS conditions contained no common letters between the CVC stimuli while MS conditions contained a single common letter and HS conditions contained two common letters.

From the results reported in Table 4-3, significant negative transfer was observed for both A-C and A-B_r paradigms across levels of similarity. Performance differences as a function of stimulus similarity were minimal and nonsignificant. In fact, negative transfer seems to increase as stimulus similarity increases. These results should however be evaluated with some caution since there were no observed differences between similarity conditions on first list performance as would be expected in view of the Underwood and Ekstrand results. This would suggest that the assumption of interstimulus similarity is suspect for the materials used in this experiment.

Underwood and Freund (1968) have been somewhat more successful in demonstrating positive transfer for HS conditions. Three experiments are reported which test the hypothesis that response items come through first list learning to function as discriminate cues for highly similar stimulus terms. The present experiments either maximized or minimized the possibility of using response items as discriminative cues in the A-C and C-D paradigms with highly similar stimuli. All Ss were given a free-learning task prior to A-B acquisition. For T conditions Ss were required to learn a list of items which were to function as stimuli in the A-B list. Here, it was assumed that the possibility of using response items as cues would be minimized since the stimuli would be differentiated prior to A-B acquisition. In the TW conditions Ss were required to learn A-B pairs thus maximizing the probability of using the response to discriminate the stimulus.

Experiments I and II used six pair lists with highly similar stimuli and response adjectives. Free learning proceeded for 15 trials with 30 sec. study and recall intervals. The results indicated that free learning of the stimulus item alone (T conditions) was significantly easier than the learning of both the stimulus and the response (TW conditions). In terms of A-B acquisition TW groups were of course significantly superior to T groups. As indicated in Figure 4-6 and confirmed by the analysis, AC-T Ss were significantly superior to CD-T and the TW groups were not significantly different. These effects were somewhat less potent in Experiment II which used similar but different materials. These two experiments taken together support the conclusion that A-C Ss may use highly meaningful response items to discriminate between highly similar stimuli thus masking positive transfer effects relative to C-D Ss.

The third experiment reported by Underwood and Freund attempted to demonstrate positive transfer for A-C Ss by using a procedure where two or more stimuli were paired with the same response thus preventing the response term from functioning as a discriminative cue. Using six different stimuli and either 2, 3, 4, 5 or 6 different response items they observed that as the number of responses increased performance also increased. They concluded that these results must be attributed to NST factors, e.g., with more responses during A-B acquisition more LTL is transferred or possibly the S developed an inappropriate "set" during A-B acquisition with fewer than six responses which transferred to the second list. To further complicate this line of reasoning Underwood, Freund and Jurca (1969) found no systematic relationship between the number of responses during A-B acquisition and transfer performance.

Kennelly (1970) has suggested that the stimulus differentiation transfer effect reported by Underwood and Ekstrand (1968) can be explained in terms of differences in the strength of first list associations for LS and HS conditions, if it is assumed that easy materials have acquired greater associative strength than difficult materials then more FAI results for Ss in the LS condition. Kennelly hypothesized that if a positive stimulus differentiation component is transferred to second list learning then this effect should be most predominant during the associative learning stage of A-C acquisition. Using seven pair lists consisting of CCC stimuli from Schwenn and Underwood (1968), and highly meaningful disyllables selected from

Noble's (1958) lists, Ss continued second list practice until a criterion of one perfect trial was achieved. With this second list criterion a stage analysis of PA acquisition was possible. The results replicated those of Underwood and Ekstrand (1968) within the response learning stage of transfer, the effects being weak and confined to early trials. This would suggest then that the HS superiority reported by Underwood and Ekstrand resulted not from a positive stimulus differentiation component but rather from greater associative interference in the LS condition. Kennelly used two measures of associative learning: (1) an associative error score, defined in terms of the mean number of errors to each pair following the first appearance of the appropriate response anywhere in the list, and (2) mean intralist response intrusions. The results provided strong evidence that stimulus differentiation does transfer as a positive component, and that this effect is confined to the associative learning stage of transfer.

A recent experiment reported by Ellis (1968) used nonsense figures as stimuli and either words or 0% association value CVCs as responses. The results indicated positive transfer in the A-C paradigm only with word responses. Similar results were obtained by Mull and Richman (1973) using 100% association value CVCs response items and either nonsense figures or two syllable adjectives as stimuli. Positive A-C transfer was evidenced only with nonsense figure stimuli. These authors suggest that as response meaingfulness decreases the total amount of time required for response learning increases resulting in decreased stimulus differentiation and a loss of positive transfer effects relative to C-D.

In general, there is good support for the notion that when stimulus differentiation is difficult then it becomes a significant transfer component which facilitates A-C relative to C-D acquisition where new and difficult stimuli must be differentiated. By and large the major transfer component in the A-C paradigm however, is FAI. The strength of this negative component would seem to be approximately equal to that observed in the A-B_r paradigm and a significantly more potent source of interference than is BAI in the C-B and A-B_r paradigms following unidirectional (A-B) practice. The strength of FAI in the A-C paradigm also seems to be weakened following bidirectional (B-A) practice. The research strategies suggested by Postman and Stark (1969) and Kanak and Neuner (1970) both offer conceivably important methodological approaches to the assessment of existing interactions between various methods of presentation and the development of component processes relevant to a particular paradigm.

C-B Transfer

Recall that Osgood's transfer surface placed the net transfer effect for C-B at zero and postulated that increasing S_1-S_2 similarity would produce increasing amounts of positive transfer. In spite of this, early research typically indicated that C-B learning was largely positive relative to C-D, (Bruce, 1933; Hamilton, 1943; and Wylie, 1919). More recent investigations have also reported positive transfer effects (Dean and Kausler, 1964; Mandler and Heinemann, 1956; and Merikle, 1968). Other studies, Dallett (1962), Goulet and Behar (1966), Kausler and Kanoti (1963), Postman (1962), and Twedt and Underwood (1959), have reported significant negative transfer effects.

It was not until Martin's conception of component processes that these conflicting results were reconciled with the interaction of secondary variables. Contemporary research has further validated the role of component processes in C-B transfer with the relative strength of response learning and BAI determining both the direction and degree of transfer.

Two of the experiments already discussed, Goulet and Behar (1966) and Crouse (1968) offer strong support for the notion of BAI in the C-B paradigm. In the Goulet and Behar experiment, bidirectional A-B and B-A practice significantly increased the amount of negative transfer with high meaningful responses. In addition bidirectional practice was observed to significantly increase B-A recall on a MFR task. In the Crouse experiment alternating A-B and C-B practice every two trials resulted in BAI which was approximately equal to that observed in the A-B_r paradigm, but somewhat less potent than the FAI exhibited by Ss with A-C practice.

An ingenious experiment reported by Johnston (1968) also investigated the role of associative interference in the C-B paradigm. Experiment I used three tasks; prior learning (PL), interpolated learning (IL) and relearning (RL). PL consisted of a six pair list presented at a 2:2 rate for 15 trials. IL consisted of either a C-B or C-D list also presented for 15 trials with a 2:2 rate. During RL Ss were given a matching task with either B or A items presented as stimuli and required to supply the appropriate items which they selected from a list of either B or A terms. The RL task consisted of two trials with a 4:2 rate.

The results indicated no differences between groups on the PL task. For the IL task (see Figure 4-7) a significant interaction between paradigms across trials was obtained, with C-B Ss being superior to C-D Ss on early transfer trials but not different on subsequent trials. This result would be expected since transfer from a response learning component would be expected to be maximal on early transfer trials where C-D Ss are encountering new responses.

Johnson also reported an analysis of type of errors which offers strong support for a component process model. If it is assumed that an omission error results from response learning while a misplacement error results from associative learning then the results presented in Table 4-4 become interpretable. Here, it is observed that as learning progresses omissions decreased and misplacements increased in frequency for both C-B and C-D Ss. In addition, there were significantly fewer omissions and more misplacements during C-B than during C-D acquisition. From a component process account,response learning should transfer as a positive component (fewer omissions) while associative learning should transfer as a negative component (more misplacements).

The RL data in Table 4-5 also supports the component process model since recall of both A-B and B-A were inhibited in the C-B condition relative to C-D. Thus associative symmetry was observed and rectroactive inhibition was bidirectional with unlearning of both B-A and A-B in the C-B condition.

Johnston points out that the C-B negative transfer effect expected from BAI was weak in Experiment I due to the relatively large positive transfer component of response learning. Experiment II eliminated the demands of response learning for C-D Ss by using a forced choice matching task where all responses were available and the S was only required to select the appropriate item. As observed from Figure 4-8 C-B Ss were significantly inferior to control Ss. Thus when C-D Ss are not required to learn new responses during transfer but only associate them with appropriate stimuli the advantage for C-B Ss is eliminated and the expected negative transfer is observed.

As indicated in Johnston's data the variable of response learning is pivotal in determining either positive or negative C-B transfer. With high meaningful responses negative transfer is usually observed since responses are learned more rapidly and a greater relative amount of associative learning results (Dallet, 1962; Goulet and Behar, 1955; Jung, 1963; Kausler and Kandti, 1963; Twedt and Underwood, 1959). With low meaningful responses on the other hand positive transfer is usually observed since a lesser amount of associative practice is involved and C-D Ss must learn new difficult response terms (Dean and Kausler, 1964; Jung, 1963; Mandler and Heinemann, 1968). The relative contribution of each component would also be expected to interact with the degree of first list learning.

As Postman (1971) points out the effect of BAI in the C-B paradigm is somewhat paradoxical since first list B-A associations do not represent competing responses during second list acquisition because the S is not required to recall the old A items. Twedt and Underwood (1959) have speculated that during second list C-B acquisition old B-A associations may function to inhibit correct responding by causing the S to reject C as the appropriate stimulus for the response item B. Thus, during the anticipation interval the C-B association results in elicition of the old B-A association and stimulus competition results. Certainly response latency data during second list acquisition would provide valuable information regarding this hypothesis. It would also seem probably that first list B-A associations interfere with effective rehearsal during the feedback interval.

Schwartz (1968) tested the Twedt and Underwood hypothesis regarding the function of BAI in the C-B paradigm by using either the same or different classes of material to enhance discriminability between lists and thus reduce competition effects between C and A items. The results however, were inconclusive since overall negative transfer effects were minimal in both stimulus conditions. This suggests that other variables, e.g., response learning, were mitigating the expected stimulus class change effect.

Olivier and Kausler (1966) have also observed that negative transfer in C-B should be less when the stimulus components (A and C) are from different form-classes than when they are from the same form-class, since there would be an expected degrease in BAI with the change in stimulus class. Procedurally Olivier and Kausler used four groups; (C) a control C-D condition where first and second list stimuli were both CVCs; (E_1) a C-B condition with CVC stimuli in both lists; (E_2) a C-B condition with first list adjectives and second list CVCs and (E_3) a C-B condition with geometric figures serving as first list stimuli and CVCs as second list stimuli. In all list conditions high m adjective functioned as response items. Using eight pair lists all Ss were given 3 warm-up trials on unrelated pairs and carried to a one perfect trial criterion on list one. As would be expected significant differences were observed between groups on A-B acquisition with list E_2 and E_3 being more difficult.

Table 4-9 presentes the total correct responses for each group across the ten transfer trials. As predicted maximum BAI was observed in the E_1 condition with groups C, E_2 and E_3 being equal. Thus, the effects of BAI would seem to dissipate somewhat when A and C stimuli represent different form classes.

In summary, the operation of component processes are drawn into sharp focus from data obtained with the C-B paradigm. The demands of the PA anticipation method, i.e., recall of response items during the anticipation interval, insure that the relative difficulty of response learning is pivotal to both the direction and degree of transfer. Additionally, it seems obvious that B-A associations developed during first list acquisition transfer negatively and interfer with C-B learning; however, the locus of the BAI effect remains elusive.

<u>A-B_r Transfer</u>

A-B_r learning requires that new associations between the same stimuli and responses as were learned during first list practice be acquired. Gagne, Baker and Foster (1950) hypothesized that the repairing of first task stimuli and responses in a second task would result in maximum negative transfer. Porter and Duncan (1953) using 12 pair lists of meaningful material compared the performance of <u>S</u>s in the A-C and A-B_r paradigms. The results indicated significantly greater amounts of negative transfer with the A-B_r lists. In general, these results have been replicated in several experiments where high meaningful material was used (Besch and Reynolds, 1958; Besch, Thompson and Wetzel, 1962; Kausler and Kanoti, 1963; Keppel and Underwood, 1962; Twedt and Underwood, 1959). However, Mandler and Heinemann (1956) have reported positive transfer in the A-B_r paradigm using single digit stimuli and low meaningful consonant syllable response terms in a mixed list design, (see Figure 4-9). Subsequent experiments by Merikle and Battig (1963) and Merikle (1968) have revealed that these conflicting results using the A-B_r paradigm can be attributed to differences in the stimulus and response materials used.

The Merikle and Battig (1963) experiment used three levels of meaningfulness in an A-B_r, A-C, C-D, mixed list design. The results presented in Figure 4-10 indicate that for the A-B_r paradigm negative transfer is observed with high meaningful material; however, when the material is low in meaningfulness the Mandler and Heinemann (1956) results are replicated, i.e., positive transfer is observed, suggesting the operation of component processes which are differentially affected by secondary variables.

The hypothesized component processes which result in the massive negative transfer relative to both A-C and C-D conditions are of course FAI and BAI. While A-C negative transfer is assumed to result from FAI alone, A-B_r transfer is adversely affected by both sources of associative interference. It should be noted that if BAI is postulated as the mechanism which results in greater negative transfer in A-B_r as compared to A-C then the BAI effect must be assumed to be strong enough to both override the positive effects of previous response learning, which has not been accomplished in the A-C condition and to produce significantly greater amounts of interference.

Crouse (1968) alternated first and second list practice and estimated the strength of FAI in the A-C task plus the strength of BAI in the C-B task to be only slightly greater than the estimated FAI and BAI in the A-B_r task (see page 100). Estimating the FAI (25.35) and BAI (16.50) separately in the A-B_r paradigm using the C-B and A-C controls respectively results in a total estimate of associative interference (41.85) which is approximately equal to the net transfer effect in A-B_r using a C-D control (C-D, A-B_r = 43.50). Thus, Crouse concludes that until more specific data regarding the development and maintenance of both forward and backward associations in the A-B_r paradigm are available it can be assumed that equal FAI is found in the A-C and A-B_r paradigms and that equal BAI is found in the C-B and A-B_r paradigms.

As in the A-C paradigm a relatively weak source of positive transfer for A-B_r learning is stimulus differentiation. Unlike the A-C list however, the A-B_r list contains an additional source of positive transfer, namely response learning, which for A-B_r Ss has been accomplished during first list practice. Both of these positive transfer components, stimulus differentiation and response learning, could be investigated manipulating variables such as interstimulus similarity and meaningfulness to delineate their relative contributions to the overall net transfer effect, however, such research is at present lacking.

A-B' Transfer

As mentioned earlier, Underwood (1951) has postulated that transfer with identical stimuli and varying degrees of response similarity is a function of parasitic reinforcement effects. An alternative to the parasitic reinforcement hypothesis has been offered by Shea (1969) who suggested the possible use of mediators in the stimulus and response generalization paradigms which function to facilitate transfer performance relative to other paradigms where the use of an effective mediator is not possible.

In the A-B' paradigm it is assumed that following A-B first list learning the S will come to use the B term as a mediator to elicit B'.

This logic follows since meaningful similarity is thought to be correlated with the degree of associative relatedness (Postman, 1971). It is thus hypothesized by a mediational account of A-B' learning that following A-B acquisition the activation of an A-B-B' chain rather that parasitic reinforcement, functions to facilitate second list performance.

The mediation hypothesis has been given considerable support from data reported by Barnes and Underwood (1959); Jenkins, Foss and Odom (1965); and Slamecka (1967). Postman (1971) has pointed out that the mediation hypothesis is supported from the Barnes and Underwood experiment since response synonyms were used with an unpaced test of recall, a condition which would enhance the opportunity to use a mediational strategy. The data indicated that A-B' learning was complete in a single trial. Additionally, the majority of Ss reported using the first list B response to help them learn the second list B' response. Substantial amounts of positive transfer have also been reported from experiments using associatively related responses (Bustian, 1961; Postman, and Stark, 1964). A recent study by D'Amato and Rugger (1971) however presents data which would suggest that positive A-B' transfer depends almost entirely on a semantic or synonymity relationship between B and B'.

This conclusion is also supported from data reported by Stark (1973) who found initial positive transfer in both synonym and non-synonym A-B' lists which shifted to negative transfer in the non-synonym condition. She suggested a component process analysis of A-B' learning with response learning representing a positive component and associative learning consisting of both interference and facilitation subcomponents which would vary as a function of meaningful similarity.

Given the assumption that B functions as a mediator eliciting B' it would seem as Stark (1973) has indicated that secondary variables such as response meaningfulness and degree of first list practice could significantly affect the ability of the B term to effectively mediate between A and B'. Another component source of positive transfer in the A-B' paradigm is stimulus differentiation. To date, however, data supporting this component process in A-B' learning is absent, but the possibility of validation remains.

Recently the notion of mediation within an A-B' paradigm has received considerable support from a series of experiments reported by Richardson (1967, 1968). Richardson (1967a) has pointed out that the mediation hypothesis suggests an interaction with length of the anticipation interval (AI). If insufficient time is allowed for the mediating process to occur and the mediated response to be made then no positive transfer should be observed. Richardson proposed to test this mediation hypothesis using three paradigms, A-B', A-C and C-D with three different presentation rates; .75:2, 1.5:2 or 3:2. The stimuli were CCC trigrams from Witmer (1935) and the responses were nouns or adjectives taken from Haagen (1949). Practice on the eight pair lists was carried to one perfect trial for both lists. Additionally, a free-recall test was given following both first list and transfer acquisition.

The results revealed no significant differences on first list learning. The results presented in Figure 4-11 indicate that on the transfer lists the total trials to criterion were 16.03 with a .75 sec.

AI, 7.11 with a 1.5 sec. AI and 6.5 with a 3.0 sec. AI. While these differences were significant, no differences were observed between the three paradigm conditions. Positive A-B' transfer was observed only with a correct response measure on trials 1-5. The support for the predicted AI x paradigm interaction was thus minimal. The free-recall data indicated that only 8 of 36 Ss in the A-B' condition recalled fewer A-B items following second list learning than they did following first list learning while as would be expected 26 of 36 A-C Ss recalled fewer items. More importantly however, there was no apparent relationship between length of the AI and the recall of first list responses. Spear, Mikulka and Podd (1966) have also failed to find differences between A-B', A-C, and C-D conditions using either 4, 2, or 1 sec. anticipation intervals.

Richardson (1967b) has reported results which serve to implicate the role of time for effective mediation. Experiment II in this article employed two presentation rates either 1:1 or 3:1 during transfer and three types of transfer either: (D) the identical stimuli and responses as in list one (letters), (B) a letter two steps removed from the letter which served as a response during first list acquisition or (1) a letter instead of a number during first list acquisition. Ss learned eight pair lists with a 2:2 anticipation procedure. Following acquisition they were completely instructed regarding the nature of the transfer task. The performance of Ss in the B conditions are of primary interest since the transfer of an effective mediator is possible with this paradigm. From Figure 4-12 it is observed that with a 1-sec. AI the B Ss exhibited little if any positive transfer relative to Ss in the 1-1 condition. However, with a 3-sec. AI Ss in the mediation condition (B-3) were superior to control Ss in the 1-3 condition. Thus the predicted AI x paradigm interaction is quite evident. This experiment differed from the previous ones on a number of potentially significant procedural variations; (1) the materials employed were not the same, (2) the study interval rates (feedback) were different, and (3) the Ss were instructed as to the nature of the transfer task in the present experiment. It is possible that any one of these three variations could have produced the observed differences in the performance of the mediation Ss.

A third experiment reported by Richardson (1968) succeeded in defining the relevant variables surrounding the role of time for effective mediation. Using the paradigms A-Synonym (A-BS), A-Antonym (A-BA) and C-D, transfer instructions were varied within each paradigm. With ten pair lists of trigram word-pairs first list practice was carried to two consecutive perfect trials with a 2:2 rate. Following A-B acquisition Ss were transferred to either a 1:1 or a 3:1 rate for ten trials.

Table 4-7 presents the results for transfer on the A-BS and C-D list for instructed and noninstructed Ss. Both the paradigm and rate of exposure variables were significant. In addition a significant AI x instructions interaction was obtained. This would suggest that instructions can facilitate performance only when there is sufficient time to utilize the information. In fact additional information tended to inhibit performance with a 1-sec. AI. The interaction between AI and paradigm was also significant. The longer AI had a greater effect for A-BS Ss than for C-D Ss, suggesting that these Ss are in fact transfering an effective mediatior while C-D Ss are not.

These results led Richardson to conclude that the relevant variable for mediation in the A-B' paradigm is the amount of study interval time. During first list practice both A-B' and C-D Ss received a 2:2 rate, with second list transfer, however, both conditions received a 1-sec. study interval. If it is assumed that A-B' Ss transfer effective mediators and that the development of mediation occurs during the study interval, then it is observed that a 1-sec. study interval will inhibit C-D performance where completely new stimuli and responses must be associated, possibly by the Ss developing his own mediator.

In general, both the hypotheses of parasitic reinforcement through response generalization and associative A-B-B' chaining have received considerable empirical support. It would seem reasonable to conclude that response similarity in terms of synonymity defines a boundary condition where effective mediation is possible. This is however somewhat confusing since associative chaining i.e., the use of effective mediators would be most readily predicted in those conditions where B' is associatively rather than semantically related to B. A prediction which is clearly not supported in the literature (D'Amato, and Rugger, 1971; Stark, 1973). Stark's (1973) suggestion that this paradigm consists of associative subcomponents which vary as a function of meaningful similarity represents an intriguing approach to the study of A-B' transfer.

Mechanisms of Transfer in S_1-R_2 and S_2-R_1 Paradigms

A Component Processes Model

Houston's net transfer surface simply involved a relabeling of Osgood's surface in accord with S_1-R_2 and S_2-R_1 similarity rather than S_1-S_2 and R_1-R_2. In the foregoing discussion of transfer mechanisms with traditional paradigms considerable support has been afforded Martin's component process model. It would seem desirable therefore to attempt a description of component mechanisms in the S_1-R_2 and S_2-R_1 paradigms. Adopting a component process approach to the analysis of S_1-R_2 and S_2-R_1 transfer demands the assumption that PA acquisition consists of stimulus differentiation, response learning and associative learning. In addition the concept of associative symmetry must be adopted. With these assumptions the delineation of four separate transfer components is achieved: (1) The effect of first list stimulus differentiation on second list response learning, defined here as the St component, (2) The effect of first list response learning on second list stimulus differentiation, the R component, (3) The effect of first list foreward associative learning on the development of second list backward associations, the F component and (4) The effect of first list backward associative learning on the development of second list forward associations, the R component. The major tenant of this model is that what is transferred is some combination of these four effects. Rather than describing net transfer effects Martin argues that an accurate description of transfer must involve separate surfaces for each component defining how a particular effect is transferred as a function of the position within the coordinate system of that particular surface. In line with this reasoning four separate transfer surfaces, one for each of the defined components, St, R, F, and B are presented in Figures 5-1 and 5-2. Within the St coordinate system it can be seen that the effect of first list stimulus differentiation on second list response learning is solely positive, and maximal when S_1-R_2 similarity is constant at identity. Thus, regardless of the relationship between S_2 and R_1, transfer will be positive in the B-A and C-A paradigms. As S_1-R_2 similarity decreases from identity the amount of positive transfer will decrease to a zero point where S_1 and R_2 are different in the B-C and C-D paradigms. Notice also that with S_1-R_2 similarity constant at neutrality, variations in S_2-R_1 similarity do not affect the prediction of zero transfer.

Regarding the effect of first list response learning on second list stimulus differentiation, the R surface, it can be seen that transfer from this component is again solely positive and maximal when S_2-R_1 similarity is constant at identity, the B-C and B-A paradigms. With S_2-R_1 identity, variations in S_1-R_2 similarity do not affect the prediction of maximal positive transfer; however, as the similarity between S_2 and R_1 decreases the predicted amount of positive transfer also decreases to a point where zero transfer is predicted when S_2 and R_1 are neutral in the C-A and C-D paradigms. With S_2-R_1 neutrality the prediction of zero transfer it is not affected by variations in S_1-R_2 similarity.

The F surface describes the predicted effect of first list forward associative learning on the acquisition of second list backward associations. It can be seen that this effect is maximally positive with S_1-R_2 and S_2-R_1 identity in the B-A paradigm. Decreases in the similarity between S_1 and R_2 with S_2-R_1 identity (As B-A varies toward B-C) results in the prediction of decreasing positive transfer. The surface also predicts that transfer will be maximally negative with S_2-R_1 neutrality and S_1-R_2 identity, the C-A paradigm. Decreasing similarity between S_1 and R_2 with S_2-R_1 identity (As C-A varies toward C-D) predicts a decreasing negative function. Holding S_1 identical to R_2 and varying S_2-R_1 similarity (B-A to C-A) results in an initial decreasing positive function followed by an increasing negative function as S_2 and R_1 become more dissimilar.

The effect of first list backward associative learning on the association of second list forward associations is described in the B surface. This component is predicted to produce maximal positive transfer with S_1-R_2 and S_2-R_1 identity in the B-A paradigm. With S_1-R_2 identity a decreasing positive function is predicted with variations in the similarity between S_2 and R_1 (as B-A varies toward C-A). With S_2-R_1 identity and S neutral with respect to R_2 (B-C) maximal negative transfer is predicted; however, as the similarity between S_2 and R_1 decreases the amount of negative transfer is predicted to decrease until S_2 and R_1 and neutral in the C-D paradigm. Holding S_2-R_1 similarity constant at identity describes an initial decreasing positive function and a subsequent increasing negative function as the similarity between S_1 and R_2 varies from identity in the B-A paradigm to neutrality in the B-C paradigm.

B-A Transfer

Regarding the position of B-A within the coordinate system of each surface it is observed that stimulus differentiation during first list practice should facilitate the acquisition of second list responses relative to conditions where no relationship existed between S_1 and R_2. In a like manner response learning during first list practice should contribute positively to second list stimulus differentiation particularly in those situations where interstimulus similarity is high and C-D Ss must therefore differentiate new stimuli.

The acquisition of forward A-B associations from first list practice should also make a positive contribution in the B-A paradigm via the backward elicitation of B in the transfer list. The learning of backward B-A associations during first list practice facilitates second list performance since A is the appropriate response item. Notice that if backward associative learning is completed during first list acquisition then second list forward associative learning is complete even before second list practice begins. In any event, the interaction of the four component processes function to produce high positive transfer in the B-A paradigm.

C-A Transfer

With new second list stimuli the R and B components of transfer do not contribute to the net transfer effect, only St and F components are involved. The differentiation of first list stimuli should function to facilitate second list response learning particularly in those situations where C-D Ss must learn new and difficult response items. First list forward associations in the C-A paradigm should contribute negatively via backward associative interference during second list acquisition.

The C-A paradigm is viewed as similar to the traditional C-B paradigm in that the positive (St) and negative (F) components are assumed to summate yielding a zero net transfer effect. Whether or not this assumption is valid remains to be seen. It would seem probably, however, that an interaction with secondary variables could result in varying positive, negative or equal transfer as compared to C-D learning. For example, the use of low meaningful material would enhance the first list value of stimulus differentiation for second list response learning, perhaps resulting in over-all positive transfer effects.

B-C Transfer

For the B-C paradigm the St and F components do not contribute to the net transfer effect since new second list responses are involved. A light positive contribution from first list response learning is predicted especially in those situations where interstimulus similarity is high and relatively difficult for C-D _S_s who must differentiate new second list stimuli. First list bakcward associative learning should interfere with the development of forward association during B-C acquisition as a function of competition between A and C items.

Again the relative contribution of each of these component processes remains to be determined. However, it seems probably that the maximal negative transfer predicted by Houston's surface is likely since stimulus differentiation has been shown to be a relatively weak component in the over-all net transfer effect with traditional paradigms.

<u>A Net Transfer Surface</u>

Taken together these paradigms B-A, C-A and B-C offer a conceivably important avenue for the investigation of processes assumed to be operative in S_1-S_2 and R_1-R_2 paradigms. For example in the C-A paradigm the positive effect of first list stimulus differentiation using different levels of interstimulus similarity can be directly assessed since the A item functions as a response term during transfer.

The debated effect of BAI can be directly assessed in the B-C paradigm since negative transfer for these <u>S</u>s can only be attributed to A and C competition. The elicitation of A by B was learned as a backward association during first list practice. Presumably bidirection practice during first list acquisition would enhance the interference encountered during the development of B-C associations. The accumulation of data regarding other secondary variable effects on both BAI and FAI in the S_1-R_2 and S_2-R_1 paradigms would also provide valuable data.

The component process model of S_1-R_2 and S_2-R_1 transfer at this point has incorporated the assumptions that St, R, F, and B components are transferred from first list practice and that first list associative learning is bidirectional. In describing a net transfer surface which interacts with the secondary variables of meaningfulness (<u>m</u>) and degree of first list learning DOL_1 it is necessary that several additional assumptions be outlined.

Martin (1965) assumed that acquisition develops temporarally with response learning preceeding associative learning in the S_1-S_2 and R_1-R_2 paradigms. This is also true in the present model. With the additional assumption that stimulus differentiation precedes the acquisition of specific first list associations it becomes apparent that the relative contribution from each transfer component is dependent on the interaction of secondary variables. For example, with low m material or low degrees of DOL_1 the contribution from St and R components relative to F and B components is maximized. In a like manner high m material or high degrees of DOL_1 would be expected to maximize the contribution from F and B components. Specifically, then a component process model predicts that when the R component transfers maximally the B component will produce minimal amounts of transfer. In a like manner, maximal transfer from the St component would be expected to result in minimal amounts of transfer from the F component. Essentially, this is the prediction of Martin's model made within the S_1-R_2, S_2-R_1 framework.

One additional assumption has been implied by the present conception of S_1-R_2, S_2-R_1 transfer. Namely, it has been assumed that transfer from the St and R components are positively correlated. That is to say a specific transfer contribution from the St component would be expected to produce a proportional amount of transfer from the R component and vice versa, since associative learning will be retarded if either St differentiation or response learning is incomplete. The critical point for the present conceptualization of transfer is that both stimulus differentiation and response learning are assumed to precede the acquisition of specific forward or backward associations, thus if secondary variables function to enhance the contribution from either St or R components then simultaneously the contribution from the other component is facilitated and associative learning is delayed.

For example, the use of low m materials would be expected to both increase the relative contribution from St and R components and simultaneously decrease the contribution from F and B components. Incorporating these assumptions, a net transfer surface for S_1-R_2 and S_2-R_1 paradigms can be described in relation to the interaction of specific secondary variables. Such a surface is depicted in Figure 5-3.

As previously outlined any prediction regarding net transfer effects with a particular paradigm (for example, C-A, B-C) varies as a function of the influence of m and DOL_1 on each of the transfer components. Within the B-C paradigm maximal positive transfer would be expected when the contribution from the R component is enhanced relative to the contribution from the B component and maximal negative transfer would be expected when secondary variables function to facilitate first list backward associative learning, (e.g., high m material or high degrees of DOL_1 practice).Essentially, the same predictions are made with the C-A paradigm regarding the interaction of secondary variables and the St and F transfer components.

It is interesting to note from Figure 5-3 that regardless of the secondary variable manipulations involved, positive transfer is predicted with the B-A paradigm. The reason for this is that increased contributions from any one of the four components is always positive. It should also be noted that relative to the C-D control condition, the amount of B-A transfer is always predicted to be proportionally greater than the amount of transfer possible in either the C-A or B-C paradigms. The logic leading to this prediction results from the specific assumptions of the component process model. In obtaining predictions for either the C-A or B-C paradigms it is necessary to consider only two of the four possible transfer components. For example, in the C-A paradigm only the St and F components can affect transfer performance since this paradigm involves S_2-R_1 neutrality. In the B-A paradigm on the other hand both S_1-R_2 and S_2-R_1 are identical, thus all four components contribute to the net transfer effect. Within the C-A paradigm maximum positive transfer is predicted when secondary variables enhance the St component, thus minimizing the F component. In the B-A paradigm however, both St and R components would be enhanced since both components transfer and affect second list performance producing proportionally greater transfer for B-A relative to C-A under similar conditions. Again in the C-A condition if the effects of secondary variables function to enhance the contribution of the B component then maximum negative transfer is predicted. Employing these same variables for B-A Ss however, would positively affect both the F and B components while minimizing the contributions of St and R components. It is logical to asrume then that regardless of the secondary variable manipulations involved, B-A transfer will be proportionally greater, than the net transfer effects observed in either C-A or B-C condition.

Secondary Variables

The Interaction with Component Processes

Martin (1965) analyzes two potent secondary variables and their assumed interaction with the component processes of transfer. These two variables, degree of first list learning (DOL_1) and meaningfulness (m) have been implicated throughout the discussion of transfer surfaces and mechanisms of transfer. The purpose of the present section is to make explicit the interactions predicted by Martin's analysis.

Recall that Martin postulated three transfer components, R, F, and B and that the net transfer effect would depend upon the specific location within each of these coordinate systems. Thus, the critical variable is to determine the locus of action for DOL_1 and m with each of the transfer components.

With $DOL_1=0$, i.e., zero first list learring all surfaces collapse into the zero plane. However, as DOL_1 increases R, F, and B assume their predicted curvatures. Consider the example the effect of increased DOL_1 on C-B with high m responses. After a few trials the B-A association (the ability of B to elicit A) increases to some asymptote where maximal negative transfer is observed. In a like manner R learning progresses in C-B as a function of DOL_1. With low m this learning develops only slowly while with high m only a few trials are required for full development.

To determine the locus of action for DOL_1 and m within each component surface requires a definition regarding the temporal relationships between the development of the individual components. For example in C-B with low DOL_1 one would predict positive transfer since response learning is assumed to preceed associative learning. Thus with low DOL_1 a positive component is transferred from the R surface and little if any negative transfer from the B surface. Obtaining a temporal definition for the separate development of component processes necessitates the assumption that R learning preceeds and overlaps association formation. The degree to which R learning preceeds associative learning being a function of other variables such as response m, (Martin, 1965).

Martin's review makes explicit the application of secondary variable constructs to each of the paradigms C-D, C-B, A-C, and $A\text{-}B_r$. Regarding the usual control for NST effects Martin defines two potential sources of confounding as a function of secondary variables. First, with low m materials it is possible that interference is enhanced because of the restricted pool of items being used. Thus, the C-D control might more appropriately be considered an $A'\text{-}B'_r$ paradigm with low m material. It would also seem probable that the C-D control is inadequate to the extent that NST effects interact with list difficulty. For example, it may well be that LTL facilitates performance on a C-D list but interfers or has little effect in the A-C paradigm where FAI is present. The validity of this argument however, remains to be determined.

It is obvious that only the R and B surfaces need to be considered for the C-B paradigm since FAI is not present with new second list stimuli. The net transfer effect from the positive R component and the negative B component are much dependent on the function of secondary variables. If response preceeds associative learning then with low DOL_1 positive transfer would be anticipated. However, as DOL_1 increases from low to high, BAI would be expected to develop resulting in increased negative transfer.

It can also be seen that with low degrees of first list response _m_, practice time would be primarily consummed by response learning and only secondarily with associative learning resulting in a positive transfer prediction for second list acquisition. With high _m_ responses, however, greater associative learning would be expected since response learning is completed early in acquisition. Martin aptly summarizes these effects, "An increase in response _m_, then means an increased opportunity for the development of negative B effects, hence either a decrease in positive transfer or an increase in negative transfer, depending on the given DOL_1, (p. 337)."

Since Martin does not consider the role of first list stimulus differentiation and neither R or B effects transfer in the A-C paradigm the only source of transfer is negative from the F component. For this paradigm as DOL_1 increases the amount of negative transfer should also increase since the low DOL_1 little associative learning has occurred. In a like manner increased levels of _m_ would be expected to increase the degree of negative transfer by increasing the amount of associative learning transferred.

A problem arises with the A-B_r paradigm since the stimuli and responses are identical. For this reason the A-B_r paradigm would occupy the same coordinate position as does A-B. But because of the rearrangement of responses, both FAI and BAI are maximized. Regarding the effects of secondary variables it can be seen that A-B_r transfer involves both FAI and BAI plus a positive R component. Hence, for those situations where R transfer is maximally positive (low DOL_1 and low m response items) it would be expected that the negative transfer effects in the A-B_r learning are weakened. In a like manner those variables which facilitate the development of FAI and BAI (high DOL_1 and high m responses) would be expected to enhance the net transfer effect in this paradigm.

Secondary Variables: Specific Paradigm Effects

Martin's conceptualization of transfer in terms of component process has provided a useful method for the integration of existing data. However, a number of questions remain unanswered. In particular the role of stimulus differentiation and A-B overlearning have become increasingly important to an understanding of transfer performance in the traditional paradigms, A-C, C-B, and A-B_r.

Degree of First-list Learning. Regarding the degree of first list practice as it effects paradigmatic transfer, it should be recalled that a two-stage analysis of response and associative learning assumes that with low DOL_1 response learning will be the dominant source of transfer, but at higher levels associative factors will become increasingly important. The interaction of the response and associative learning stages and DOL_1 is of course dependent on response m.

An early study by Bruce (1933) found that as DOL_1 increased from 6 to 12 trials, transfer performance on a 9 pair CVC list became increasingly positive in the C-B paradigm and increasingly negative in the A-C paradigm. Mandler and Heinemann (1956, see Figure 4-9) also reported increasing positive transfer in both C-B and $A-B_r$ paradigms using a mixed list design with DOL_1 criteria of 0, 10, 30, 50, or 100 trials. The use of a mixed list design, however, limits generalization from these data since only two pairs per paradigm were employed. Notice for example that the $A-B_r$ paradigm produced greater positive transfer effects than did C-B. In the A-C paradigm an initial increase in negative transfer from 0 to 10 DOL_1 trials is reversed to decreasing negative transfer from 10 to 50 DOL_1 trials and then back to an increasing negative function from 50 to 100 trials. While these differences were not significant the trends suggests that Ss acquire the ability to effectively differentiate between correct and incorrect response as DOL_1 practice increases.

A study by Jung (1962) partially supports these data using lower levels of first list practice, either 3/6 or 6/6 + 5 trials, and higher m material, adjective stimuli and trigram responses. For the A-C and $A-B_r$ paradigms decreasing negative transfer was observed; however, in the C-B paradigm a shift from positive to negative transfer was observed as DOL_1 increased, see Figure 6-1. Dean and Kausler (1964) have also reported a shift from positive to negative transfer for C-B Ss as DOL_1 increased from 3/6 to 6/6 + 5 additional trials, using high m CVCs.

While the previous studies have all employed CVC or CCC response materials an experiment by Postman (1962) has utilized high m adjectives as responses with DOL_1 criteria of 6/10, 10/10, or 10/10 plus 50% overlearning. As indicated in Figure 4-2 negative transfer effects were observed for the three paradigms C-B, A-C, and $A-B_r$. Both the C-B and the A-C paradigms represent decreasing negative transfer functions while $A-B_r$ is observed to increase in the amount of negative transfer as DOL_1 increases.

Homzie, Weimer, Schwartz and Waters (1969) have reported data which supports the notion of component processes in transfer and an interaction with secondary variables. These authors reasoned that transfer performance in the C-B and $A-B_r$ paradigms should be both facilitated as the degree of first list learning increases, via a R learning component, and inhibited as backward associative learning processes. By increasing the degree of intralist response similarity (IRS) the positive effects of response learning should also be enhanced with greater DOL_1. In a like manner low degrees of IRS would be expected to have less of a facilitating effect as DOL_1 increases. Homzie, et. al., also propose that the transfer of response learning can be investigated using paradigms where the transfer list responses function as first list stimuli (C-A and $B-A_r$ paradigms). In these paradigms integration of second list responses is not required to learn the first list since these items function as stimuli. Here the interaction between IRS and DOL_1 would not be expected to be as potent as when transfer and initial list responses are identical.

With CVC responses and adjective stimuli IRS was varied from high (3 consonants only) to low (12 different consonants) and DOL_1 was varied from low (3/6 correct responses) to high (6/6 correct responses plus one study trial). Separate control groups were yoked for number of practice trials during first list acquisition.

Figure 6-3 presents the expected differences in first list performance and the performance across the ten transfer trials. The analysis revealed a significant IRS x DOL_1 interaction. DOL_1 appears to be a much more potent variable with HIRS, since there was no effect with LIRS. That is, for C-B and A-B_r conditions positive transfer was evident only with HIRS. The predicted 3-way interaction was not obtained since conditions C-A and B-A_r were affected by DOL_1 and IRS in a manner similar to that in C-B and A-B_r conditions suggesting that stimulus learning was equivalent to response learning in original list acquisition resulting in the DOL_1 and IRS interaction being significant for both C-B, A-B_r and C-A, B-A_r paradigms.

Schulman (1967) investigated two levels of first list learning (either 1/10 correct or 5/10 correct) with the paradigms A-B_r, A-C, C-A or C-D. Using common occurring response words it was thought that with low DOL_1 the major transfer component would be due to response learning. The A-C paradigm was employed to provide an estimate of that portion of the transfer effect observed in the A-B_r paradigm due to FAI. The magnitude of the negative transfer which was expected for the C-A paradigm was thought to provide an indication of BAI in the A-B_r paradigm. Thus, Schulman has assumed that first list forward and backward associative learning is symmetric and that forward associations acquired by C-A Ss are equivalent to the backward associations acquired by A-B_r Ss, this would seem a tenuous assumption given Crouse's (1968) data and the extremely low levels of DOL_1 employed.

Ten pair lists of CVC stimuli and high frequency nouns were used. C-A Ss learned stimulus nouns and CVC responses. From the data in Figure 6-4 differences between the 1/10 and 5/10 criterion were not significant. With the 1/10 criterion A-C and A-B_r were significantly inferior to C-A and C-D. In addition with the 5/10 criterion A-B_r was also significantly inferior to A-C.

Schulman concludes that forward associative learning in the A-B list does not produce negative transfer via BAI in the second list for C-A Ss. This conclusion remains tenuous for two reasons: (1) The atypical use of noun stimuli and CVC responses during first list acquisition as compared to C-D pairs composed of CVC stimuli and noun responses, and (2) The extremely low levels of first list learning employed. Schulman then concludes that negative transfer observed in the A-B_r paradigm is in no part a function of BAI. This conclusion too would seem tenuous. It would seem equally probable that stimulus differentiation during first list learning transferred positively to facilitate learning during second list acquisition for C-A Ss, as was found in the Homzie, et.al., (1969) study. In addition if BAI is excluded as a source of negative transfer in the A-B_r condition, then how is it possible to account for the significant differences observed between the performance of A-C and A-B_r Ss with a first list criterion of 5/10? Since both paradigms would be expected to contribute equal FAI and A-B_r contains a positive component from R learning, why is learning retarded in this condition? Schulman's exclusion of the BAI mechanism would seem erroneous. It is more probable that the C-A paradigm does not provide an adequate estimate of BAI in the A-B_r paradigm with extremely low DOL_1 levels.

The study does provide good descriptive support for Martin's conception with both A-C and A-B_r performance deteriorating with increased first list practice. This would be expected with increased associative learning producing greater interference during second list acquisition

In summary, the evidence for increasing negative transfer as first list practice increases, as predicted from a component process model, is conflicting in the studies reviewed. While the evidence seems to confirm the importance of response learning as a source of positive transfer, increased associative learning has been observed to both increase and then decrease the relative amount of negative transfer as a function of DOL_1.

Meaningfulness. As mentioned, Mandler and Heinemann (1956) reported increasing positive transfer for the $A\text{-}B_r$ paradigm. Merkile and Battig (1963) replicated these effects with low *m* material; however, with high *m* material $A\text{-}B_r$ produced significant negative transfer. In a similar manner A-C transfer was observed to produce increasing negative transfer as *m* increased. Jung (1963) using adjective stimuli and trigram responses also reported negative transfer in the A-C paradigm to be significantly greater with high *m* responses. In the C-B paradigm low *m* responses produced high positive transfer while high *m* responses resulted in C-B and C-D equivalence, (see Figure 6-2).

Goulet (1965) has factorially varied first and second list response *m* in the A-C paradigm. With the levels of *m*, either high (H) or low (L) four experimental conditions were tested: $H_1\text{-}H_2$, $L_1\text{-}L_2$, $H_1\text{-}L_2$, and $L_1\text{-}H_2$. Using Archer (1960) CVCs to define response *m* the results presented in Table 6-1 indicate greater negative transfer following first list acquisition of high *m* responses, conditions $H_1\text{-}H_2$ and $H_1\text{-}L_2$.

Merikle (1968) reported the results of an experiment in which both stimulus and response m were manipulated factorially for the paradigms, A-C, A-B_r, C-B and C-D. Using high and low levels of m there were four conditions within each paradigm: H-H, H-L, L-H, and L-L. The procedure used to accomplish PA acquisition was somewhat atypical, study and test trials were alternated with pairs being dropped following a correct response. The final trial again presented all eight pairs.

The result in Table 6-2 indicate some support for a component process model. With the A-C paradigm in the H-H condition significant negative transfer is observed due to greater associative A-B acquisition. In L-H conditions the amount of negative transfer was surprisingly low considering that high m responses were used. The H-L and L-L condition yielded zero net transfer since the requirements of response learning were more difficult resulting in less FAI during second list acquisition.

In the C-B conditions, decreasing positive transfer was observed as a function of increasing response m. It is somewhat surprising, however, that negative transfer was not observed with high m responses. It is possible that the particular procedure used prevented the strong development of backward associations in this paradigm. This is also supported by the observed difference between groups A-B_r and A-C in the H-H condition where A-C Ss were inferior to A-B_r Ss. A component processes analysis would suggest that A-B_r should be inferior as a function of both the FAI evident in the A-C condition and in addition a negative component from BAI. This was not observed in the present data. The most intriguing implication of this study is the lack of expected negative transfer resulting from BAI in the A-B_r and C-B paradigms. As mentioned the procedural variation of eliminating a pair following a correct response to it may mitigate the development of backward associations. This would imply of course that forward associative learning temporally preceeds backward associative learning, and represents an interesting area for further research.

From Association to Structure: Mandler's Hypothesis

From the data reported by Mandler and Heinemann (1956), Postman (1962) and Jung (1962) it was observed that negative transfer in the A-C paradigm has been found to level off or decrease as a function of increased first-list practice. Martin's component process model would predict negative transfer in the A-C paradigm to be an increasing rather than a decreasing function of DOL_1 since the model assumes that first list A-B associations produce FAI during second list acquisition and increase in strength with A-B overlearning.

Mandler (1962) in a review of relevant animal and human studies has proposed that negative transfer initially increases and then decreases as a function of first task overlearning to form a U-shape function. This review attempts to account for overlearning effects in negative transfer paradigms in terms of cognitive "structures" which develop from associationistic processes. These cognitive structures are posited to represent the development of "symbolic analogues" of the first list associations which facilitate covert or implicit trial-and-error learning. Mandler assumes that these symbolic analogues are highly integrated response sequences which can function independently of overt responses and thus reduce negative transfer effects as they develop with increased first list practice.

Jung (1965) has objected to Mandler's postulate of cognitive structures. Jung points out that reference to the animal learning literature is inappropriate since the discrimination learning tasks used, i.e., the overlearning reward paradigm, are quite dissimilar to an A-C transfer task. In addition, the animal learning experiments have not included an NST control condition. Of the human learning studies referenced, only the Mandler and Heinemann (1956) experiment contained an NST control; however, Jung points out that data which were not available to Mandler also supported the notion of a U-shaped function in the A-C paradigm (Jung, 1962; Postman, 1962).

Postman (1963, 1971) has proposed an alternative to the notion of symbolic analogues which suggests that the interlist differentiation of responses, i.e., the ability of S to distinguish list membership of responses, increases with increased L_1 learning. Mandler (1965) has agreed that the postulate of "structures" may be similar to that of interlist response differentiation.

Jung (1967) has tested the hypothesis that interlist response differentiation increases as a function of first list practice using CVC stimuli and Haagen two syllable adjective responses. With two levels of first and second list practice, either 6/9 or 2 consecutive errorless trials, the results presented in Figure 6-5 indicate that negative transfer significantly increased with higher degrees of second list practice, but was not effected by the degree of first list learning. Interlist response differentiation was measured immediately following completion of the second list. All responses from both lists were presented individually and the S was required to identify the appropriate list for each item. These measures indicated that response differentiation was complete and equal for all conditions. As indicated in Table 6-3 the group means ranged from 16.2 to 17.5. Jung explained these results with the hypothesis that an intralist stimulus differentiation component is in fact transferred in the A-C paradigm which functions to mitigate increased FAI effects.

Taken together these data coupled with those of Underwood and Ekstrand (1968) and Kennelly (1970) would suggest that a component process analysis of transfer must incorporate the concept of stimulus differentiation to provide an adequate description of the interaction between specific transfer components and secondary variables. Since Kennelly (1970) has reported data which would suggest that the positive contribution of stimulus differentiation becomes effective only during second list associative learning much needed research in this area would involve a stage analysis of A-C transfer performance following A-B overlearning.

Martin's Encoding Variability Hypothesis

As suggested by the previous data, current research efforts have primarily been concentrated on secondary variables and their interaction with response items. A recent review by Martin (1968) has however, focused attention on the role of stimulus meaningfulness as it effects transfer performance.

Martin's hypothesis evolves around the notion that associative PA learning varies as a function of perceptual encoding responses which are made to a particular stimulus (St). The perceptual encoding response possible from a St of high m was hypothesized to consist of a single unitary element. The number of perceptual encodings possible from a low m St however, were assumed to be numerous. Using this logic Martin further hypothesized that the amount of negative transfer observed in the A-B_r paradigm would decrease as a function of decreasing St m, since with low m St multiple possible encodings should lessen the amount of FAI from first list A-B acquisition. That is to say, a new response can be more easily associated with a new stimulus when the St m is low and a new functional St can be employed by the S. For example, if the nominal St were "KUV" then during first list acquisition the functional St "UV" might become associated with the response "CHAIR". During transfer the same nominal stimulus "KUV" might be encoded KU and associated with the new response "SKY". On the other hand with high m St only a single perceptual encoding is possible, hence the amount of negative transfer would be maximal, e.g., the stimulus "JOY" would be functionally encoded as "JOY" and associated with the response. During transfer the FAI would be great since the same functional stimulus is eliciting two different responses.

Martin tested this hypothesis with the A-B_r paradigm using a C-B control to equate both response learning and BAI. The prediction then is that A-B_r transfer should approach that of C-B with low m material. Procedurally, there were four groups in a 2 x 2 factorial with two paradigms and two levels of St m. All Ss first learned a 6 pair A-B list followed by practice on the appropriate transfer list. Ss then relearned the A-B list and were given a free recall test for the retention of A items.

Using a $100(T_1-T_2)/T_1-T_2$ transformation the data in Figure 6-6 indicate large differences between low and high m St within the A-B_r

paradigm but not within the C-B paradigm, since FAI would be expected only for A-B_r Ss. The observed difference within the A-B_r condition supports the prediction regarding use of a functional stimulus by low m A-B_r Ss. The C-B low versus A-B_r low comparison was not significant while the C-B high versus A-B_r high comparison indicated substantial and negative transfer again supporting the hypothesis. Martin concludes that these transfer results "are precisely those predicted on the assumption that low-m St can be encoded in a greater variety of ways than can high-m St, and hence can provide more alternative recoding routes in a negative transfer situation, (p. 432)".

The task 3 relearning of A-B results were nearly identical in the relationship between the four conditions, leading to the conclusion that "in the A-B_r paradigm, it is easier to get back to the original task 1 pairings when the St are low m than when they are high m again suggesting recoding of low m St but unlearning of high m St, (p. 432)".

The recall test of A items were 3.5, 3.6, 5.9, and 5.85 for the conditions A-B_r low, C-B low, A-B_r high and C-B high respectively. This supports the notion of a functional St with low m material, i.e., with high m material the nominal functional St are identical, hence recall is superior. With low m material the S is recalling a functional St which is different from the nominal St and thus incorrect.

The encoding variability hypothesis is also aupported from Merikle's (1968) data, presented in Figure 6-2. These data indicate a marked decrease in negative transfer in the A-B_r condition when St m is varied from high to low with high m responses. Ss with low m St would be expected to employ different functional stimuli for A-B and A-B_r pairs thus reducing the amount of response competition during second list learning.

The encoding variability hypothesis is of course predicted on the assumption that Ss both recognize and employ an available strategy. Recent data reported by Goggin and Martin (1970) and Williams and Underwood (1970) would indicate, however, that encoding variance may be of a lesser magnitude than originally hypothesized. Weaver, McCann, and Wehr (1970) have in fact failed to obtain an St m effect in the A-C paradigm. Martin (1971) suggests that experimental procedures employed in PA experiments are often insensitive to the encoding variability. For this reason Read and Scarlett (1973) have incorporated a free-pairing technique where each S is allowed to construct their own pairs for learning from lists of stimulus and response items. The free-pairing procedure has been shown by Brown and Read (1970) to produce positive transfer in both the A-C and A-B_r paradigms. Read and Scarlett reasoned that allowing the S to construct his own PA pairs would encourage the use of functional encodings, and mitigate FAI effects in the A-C paradigm.

Using two levels of stimulus and response m, defined by Pavio, Yuille and Madigan (1968), Ss learned either an A-C or a C-D list under a study-test procedure. The mean percentage transfer scores for the conditions, LL, LH, HL, and HH were -6.0%, 24.0%, -2.0% and .5%. These data indicate that increased St m had little effect on transfer performance when R m was low but produced decreased positive transfer with high m responses. The results are then in clear opposition to Martin's hypothesis under conditions where the possibility for using a stimulus encoding strategy were enhanced.

Carlton and Greeno (1970) have also reported data which would seem to conflict with predictions from an encoding variability hypothesis. In three separate experiments using either digits or adjectives as stimuli or responses, first list overtraining failed to increase negative transfer in the A-B_r paradigm relative to a C-B control. While the absence of increased negative transfer using digit-adjective pairs would be expected from Martin's hypothesis, it would also be predicted that using adjective-digit pairs, negative transfer would increase as a function of overtraining as more encodings became associated with the first list response. Carlton and Greeno (1970) reported the absence of an overtraining effect under these conditions, and suggest that the encoding variability hypothesis be extended to include the response items. They reason that stimulus-response pairs are stored as single units and that the presence of a unitary item discourages multiple encodings of the complementary member of a pair. This would of course explain the absence of decreased negative transfer in the Read and Scarlett (1973) data.

Verbal Discrimination Transfer

A Frequency Theory Account of Transfer

In 1966, Ekstrand, Wallace, and Underwood proposed a frequency theory account of verbal discrimination (VD) learning. Briefly the theory asserts that as a function of four mechanisms, representation, pronunciation, rehearsal, and associative relatedness, units of frequency accrue differentially to right (R) and wrong (W) items in a pair. The development of this frequency differential is thought to provide the basis for a subjective discrimination between R and W items and is thus the proposed basis for VD learning.

If the initial development of a frequency differential between R and W items in a VD pair provides the basis for discrimination, then this frequency information should transfer to a second list which involves either W_1-W_2 or R_1-R_2 similarity. To account for transfer performance in a VD task Ekstrand et. al., have defined two rules of operation based on the development of a frequency differential which facilitates discrimination. Rule 1, behavior involves always selecting the more frequent of two alternatives while Rule 2 behavior involves always selecting the less frequent of two alternatives. It can be seen that if the transfer list involves old R items but new W items (A W_1-R_1, W_2-R_1 paradigm) performance is optimized using a Rule 1 strategy. If the transfer list involves new R items but old W items (A W_1-R_1, W_1-R_2 paradigm) performance is optimized via the use of Rule 2.

However, the hypothesized use of a Rule 2 leads to a very interesting prediction regarding transfer performance. If the S early in transfer adopts a Rule 2 strategy then as acquisition progresses the frequency differential between W_1 and R_2 should equalize as R_2 begins to accumulate frequency units. At that point in the acquisition of a W_1-R_2 discrimination where the R:W ratio has equalized the theory predicts a performance deficient since the S is unable to discriminate using either rule. The S must then shift to a Rule 1 approach, again selecting the more frequent alternative, in this case R_2.

Developmentally frequency theory had its beginnings in a study by McClelland (1942) where he reported high positive transfer in the W_2-R_1 paradigm (Rule 1) and comparatively retarded performance in the W_1-R_2 paradigm (Rule 2). Underwood, Jesse and Ekstrand (1964) replicated these results. In addition they noted that if a Rule 2 is employed by the S in the W_1-R_2 task, transfer is at first positive but as the new R item gains in frequency, negative transfer is evident and the S must subsequently shift to a Rule 1 approach. Kausler and Dean (1967) extended this logic to include the paradigms W_2-R'_1 and W'_1-R_2 where high associates of the original R and W items were used and Ss were not instructed as to the relationship between lists. Results from the W_2-R_1 and W_2-R'_1 conditions were consonant with the predictions of frequency theory. Contrary to earlier results however, performance on the W_1-R_2 and W'_1-R_2 lists was inferior from the beginning of transfer. It would appear then that Ss did not employ the Rule 2 strategy. Raskin, Boice, Rubel and Clark, (1968) provided good support for the operation of a Rule 2 as outlined and also verified that instructions seem to be of critical importance especially when the transfer lists involve associates of the first list R or W items. While these experiments all implicate the role of frequency in VD transfer, relatively little attention has been given to the possible role of incidentally learned associations between W_1 and R_1. The abundance of evidence regarding intentionally learned associative components of transfer in a PA task should serve to implicate these components in a VD task.

Associative Mechanism in VD Transfer

Kausler, Fulkerson and Eschenbrenner (1967) concluded that in W_1-R_2 paradigms associative interference results from competition between incidentally learned W_1-R_1 associations during first list practice and incidentally learned W_1-R_2 second list associations. The experiment employed three groups: (Group E) where Ss transfer to a W_1-R_2 lists, (Group C_1) where Ss transfer to a W_2-R_2 NST control list and (Group C_2) a normal forgetting control where Ss performed on unrelated tasks. All Ss learned the 15 pair W_1-R_1 lists to a criterion of one perfect trial followed by 10 transfer trials. All Ss were then given a MMFR task being required to recall both the R_1 items on List 1 and the R_2 items on List 2. The results indicate nonsignificant difference between groups, E, C_1 and C_2 on first list acquisition. In addition Group E and C_1 were not significantly different on second list performance.

The competition-unlearning hypothesis predicts that W_1-R_1 recall for Ss receiving W_1-R_2 pairs on List 2 should be less than that for Ss receiving W_2-R_2 paris. The recall data support this conclusion, with Group E being significantly inferior to both C_1 and C_2. Group C_1 was also significantly inferior to the normal forgetting control (C_2) on some measures.

As was suggested earlier by Kausler (1966) the present results were interpreted within a two-component process notion of VD transfer where the application of a frequency rule is viewed as essentially an intentional component of learning while the acquisition of W_1-R_1 associations during first list practice are assumed to be learned incidentially. The apparent competition-unlearning which inhibited recall for E Ss in the present study is supportive of the incidental associative interference notion.

While VD transfer is usually considered to be positive in the W_2-R_1 paradigm as a function of continued Rule 1 behavior Eschenbrenner and Kausler (1968) have implicated the unlearning mechanism as a source of associative interference. Even with over-all positive transfer effects for this paradigm evidence is presented which suggests that incidentially acquired W_1-R_1 associations are unlearned. The experiment used three primary groups: (Group E) where Ss received a W_1-R_1 list which was learned to a criterion of one perfect trial followed by five trials on a W_2-R_1 list, (Group C_1) the NST control with W_1-R_1 and W_2-R_2 list conditions and (Group C_2) a normal forgetting control condition with W_1-R_1 learning followed by practice on an unrelated task. Following second list practice for Groups E and C_1 all Ss were given a MFR test being presented with the first list R items and asked to recall the appropriate W items in an unpaced procedure.

The results indicated significant positive transfer for W_2-R_1 Ss relative to the W_2-R_2 control. The MFR data supported the hypothesized associative interference component of transfer in that W_1 recall for W_2-R_1 Ss was inferior to both the W_2-R_2 Ss and the normal forgetting control Ss.

This component theory of VD transfer was given further support in two experiments reported by Kanak and Dean (1969). Essentially the paper proposes an extension of the Osgood transfer surface to VD learning to account for the incidentally component of transfer.

The width of the surface represents the degree of similarity between W_1 and W_2 from identity to neutrality. The length of the surface describes transfer as a function of the degree of similarity between R_1 and R_2. The surface thus predicts that with wrong item identity transfer will be maximally positive with R item identity. As the similarity between first and second list R items decreases transfer is initially a decreasing positive function followed by an increasing negative function until second list R items are neutral with respect to those in the first list (W_1-R_1 varied to W_1-R_2). At this point maximal negative transfer is predicted by the surface. With R item identity, decreasing similarity between first and second list W items would be expected to produce decreasing amounts of positive transfer (W_1-R_1 varied to W_2-R_1). In a similar manner with R item neutrality decreasing similarity between first and second list W items would produce decreasing amounts of negative transfer (W_1-R_2 varied to W_2-R_2).

Using a 3 x 3 factorial design with W_1-W_2 and R_1-R_2 similarity varied from identical to associate to neutral, the predictions of the surface were tested by Kanak and Dean (1969). Each list consisted of 15 pairs present with the anticipation procedure. First list acquisition was carried to a criterion of two consecutive errorless trials while second list practice was continued for 10 trials.

The results depicted in Table 7-1 indicate that with R item identity and W item similarity varied, transfer is highly positive. This suggests that in those paradigms where a Rule 1 is applicable the transfer effect of incidentally learned associations are mitigated. While the effects of associative interference are not observed in the transfer measure it should be recalled that Eschenbrenner and Kausler found inferior recall in the W_2-R_1 paradigm.

The effects of associative interference were more strongly supported in those paradigms where a Rule 2 rather than a Rule 1 was the appropriate frequency strategy with performance in the W_1-R_2 condition being significantly inferior. It should also be noted that the paradigms W_2-R'_1, W'_1-R'_1 and W_1-R'_1 were not significantly different from W_2-R_2 as predicted by the surface. Taken together these results provide rather strong support for a two component process notion of VD transfer.

The second experiment reported by Kanak and Dean offered additional support to the notion of incidentally learned assocative interference by testing both corresponding (C) and noncorresponding (NC) transfer conditions. An NC condition being defined in terms of a re-pairing of W and R items. The C and NC conditions tested were W_1-R_1, W'_1-R_1 and W_1-R'_1. A NST W_2-R_2 control was also employed. Frequency theory of course would predict no differences between C and NC conditions since the appropriate rule of performance should be the same regardless of the pairing between R and W items.

The results in Table 7-2 indicate a main effect for both paradigms and C versus NC conditions. Performance in the W_2-R_2 group was 13.87 mean errors. With the exception of the W_1-R'_1 NC condition the performance in all groups was superior to that of the W_2-R_2 control. The more important result, however, is the significant difference between C and NC conditions which can not be accounted for by frequency theory alone.

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APPENDIX B

PROSPECTUS FIGURES

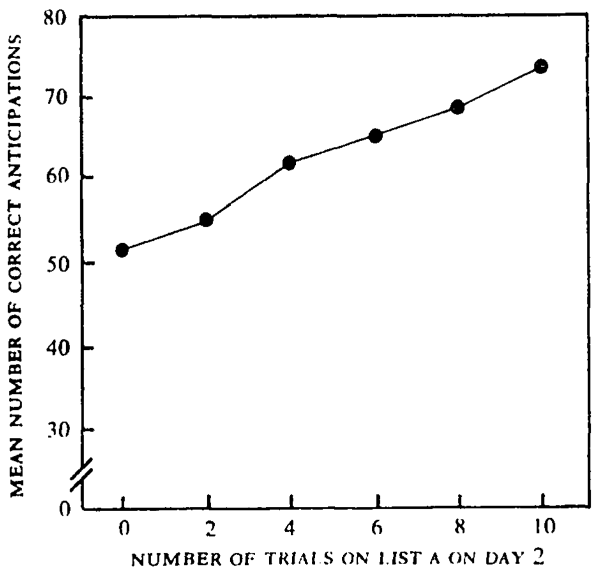

Figure 1-1 Mean correct anticipation for ten List B trials (Thune,1950)

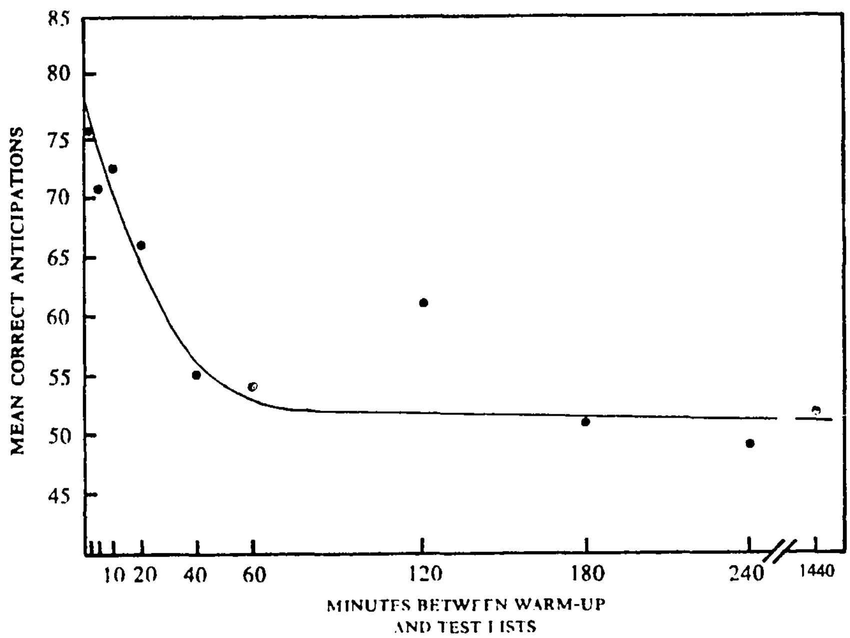

Figure 1-2 Mean correct anticipations across ten test list trials following 9 different rest intervals. The 1440 min. interval was taken from Thune (1950). (Hamilton, 1950)

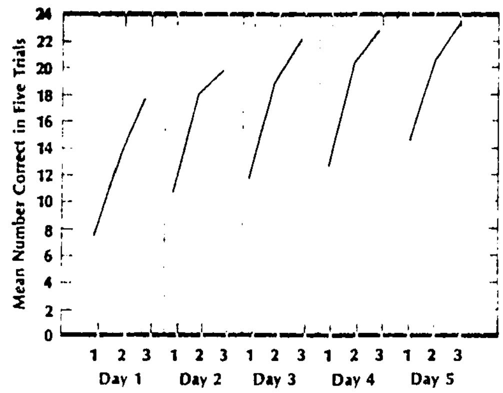

Figure 1-3 Temporal gains in NST with continuous practice. Three separate PA lists were learned on each of 5 days. (Thune, 1951)

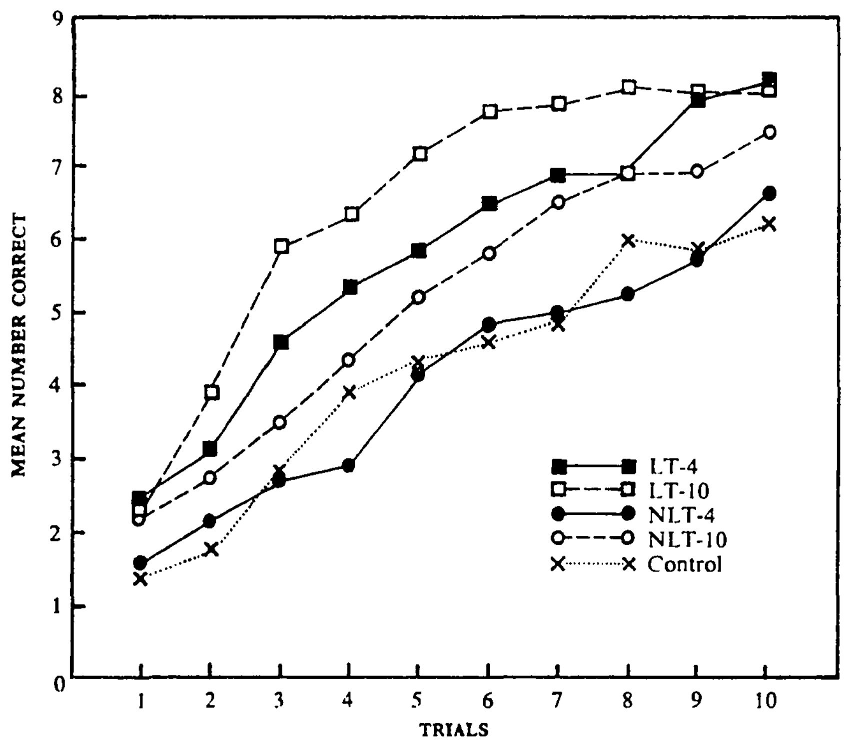

Figure 1-4 Acquisition curves during test list learning. Groups LT received a PA task for 4 or 10 trials while groups NLT received a number guessing task. (Schwenn & Postman, 1967)

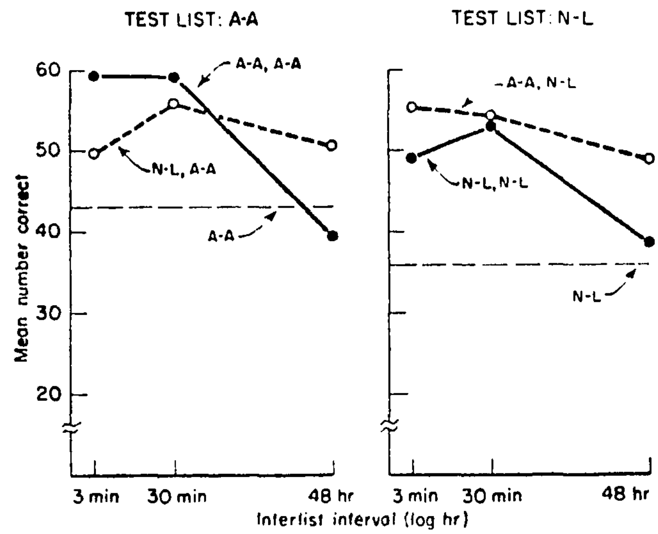

Figure 1-5 Mean number of correct anticipations during test list learning as a function of both the condition of transfer and the length of the interlist interval. (McVaugh & Postman, 1969)

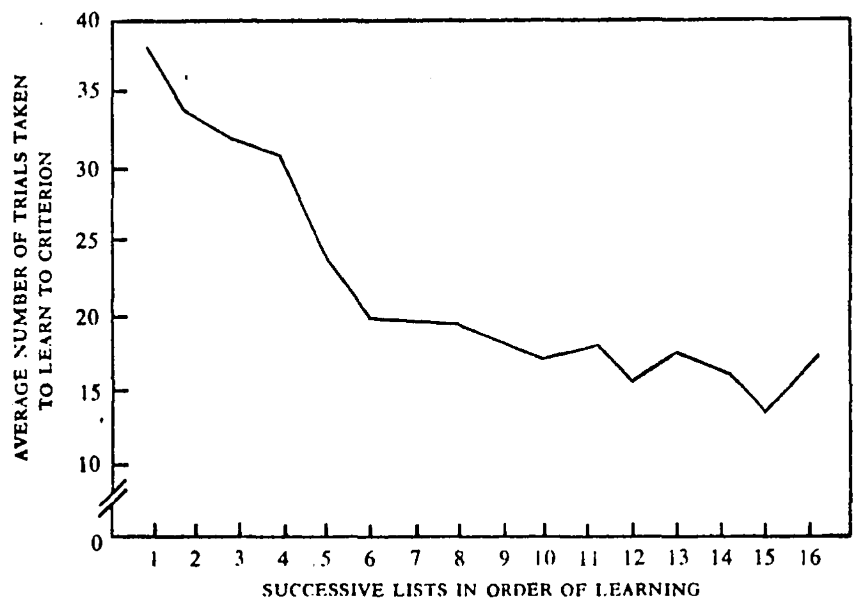

Figure 1-6 A cummulative acquisition curve depicting changes in the rate of learning for 16 successive lists of 12 nonsense syllables. (Ward, 1937)

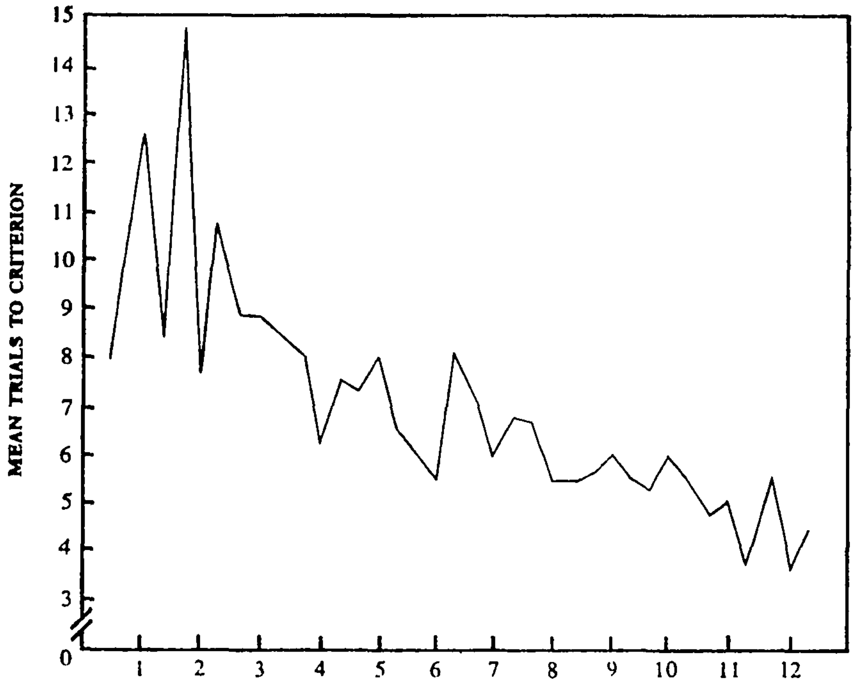

Figure 1-7 Mean trials to criterion as a function of successive blocks of three lists. (Keppel, Postman, Zavortink, 1968)

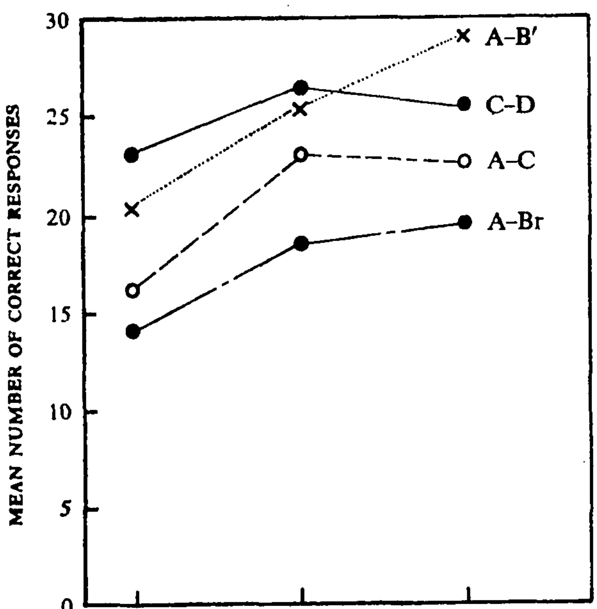

Figure 1- 8 Mean correct anticipation during second list learning as a function of set and paradigm. (Postman, 1964)

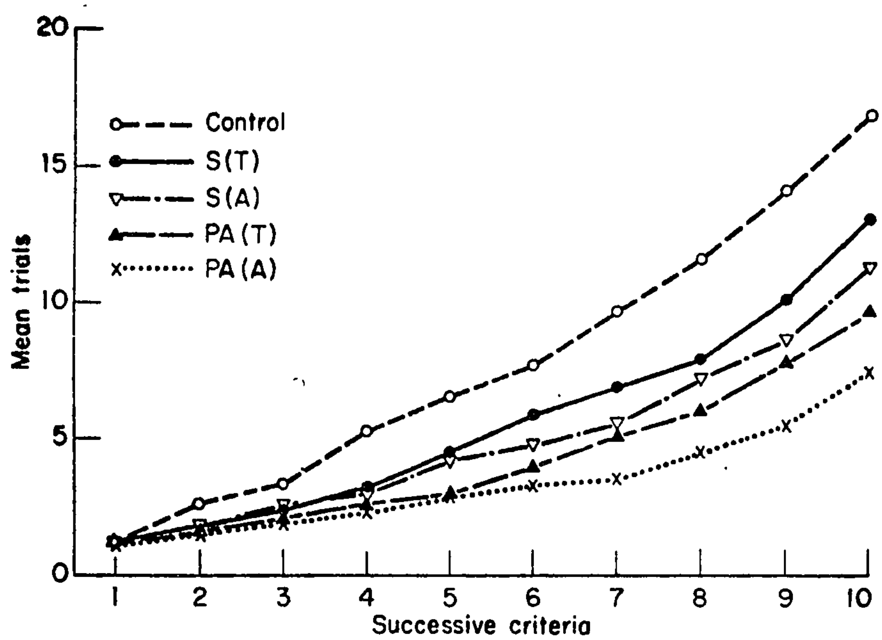

Figure 1-9 Mean trials to successive criteria on a PA list following practice on either a PA or serial list composed of adjective (A) or trigram (T) material. (Postman & Schwartz, 1964)

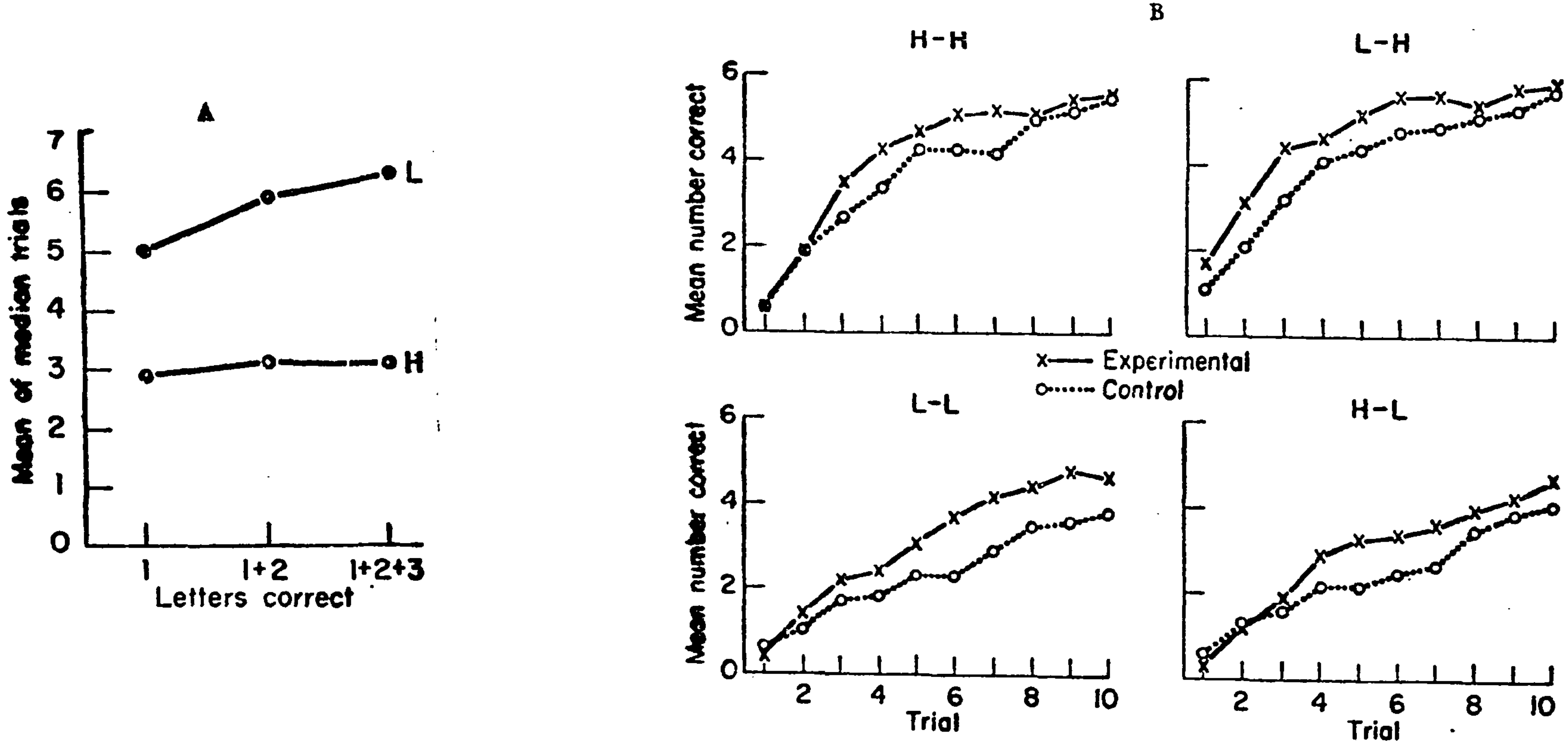

Figure 1-10 (A) Trials in List-1 learning on which Ss first gave 1, 2, & 3 correct letter of response terms. (B) Mean number of correct anticipation during List-2 learning. (Postman, Keppel & Zacks, 1968)

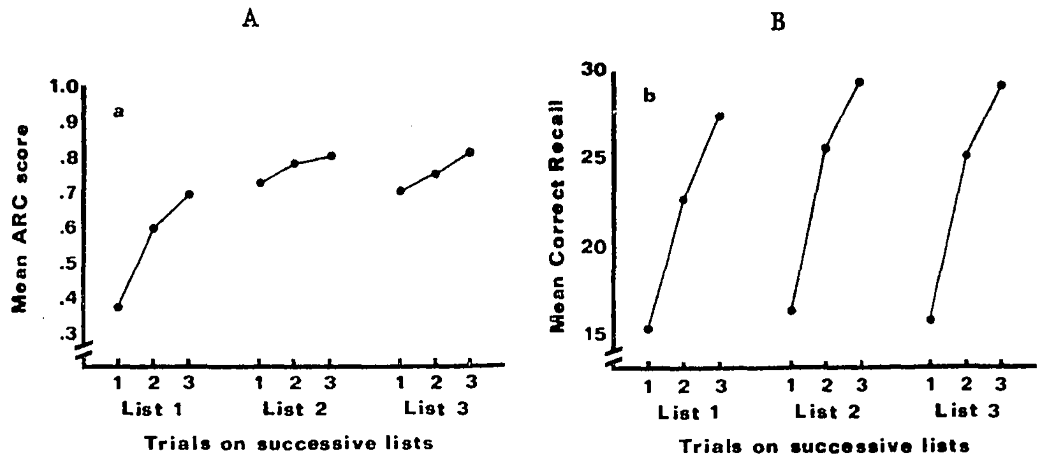

Figure 1-11 (A) Mean adjusted ratio of clustering (ARC) scores for each of three lists. (B) Mean correct recall for each of three lists. (Thompson & Roeneker, 1971)

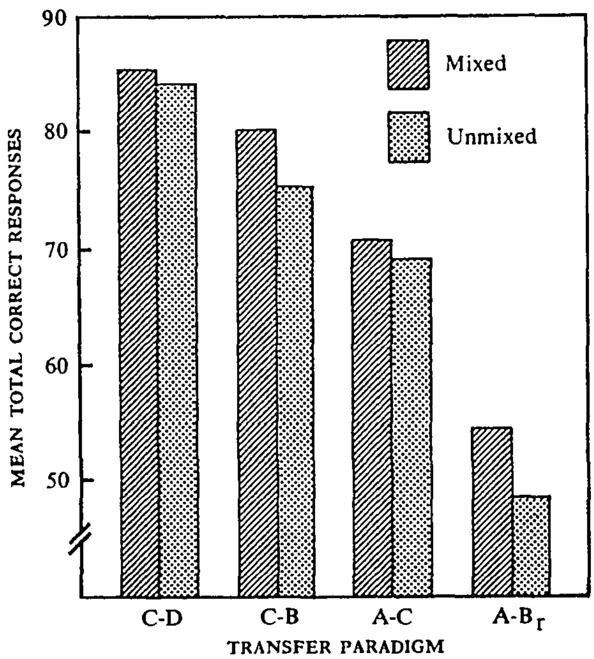

Figure 2-1 Total correct responses across ten transfer trials as a function of mixed and unmixed list design and transfer paradigm. (Twedt & Underwood, 1959)

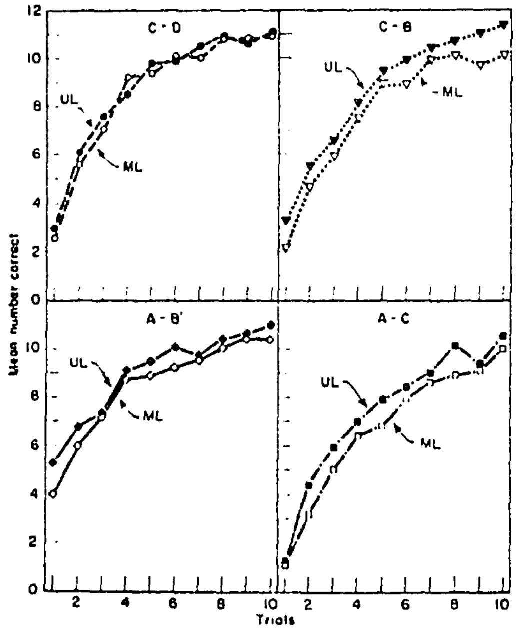

Figure 2-2 Mean correct responses across ten transfer trials for each of four paradigms in both mixed and unmixed designs. (Postman, 1966)

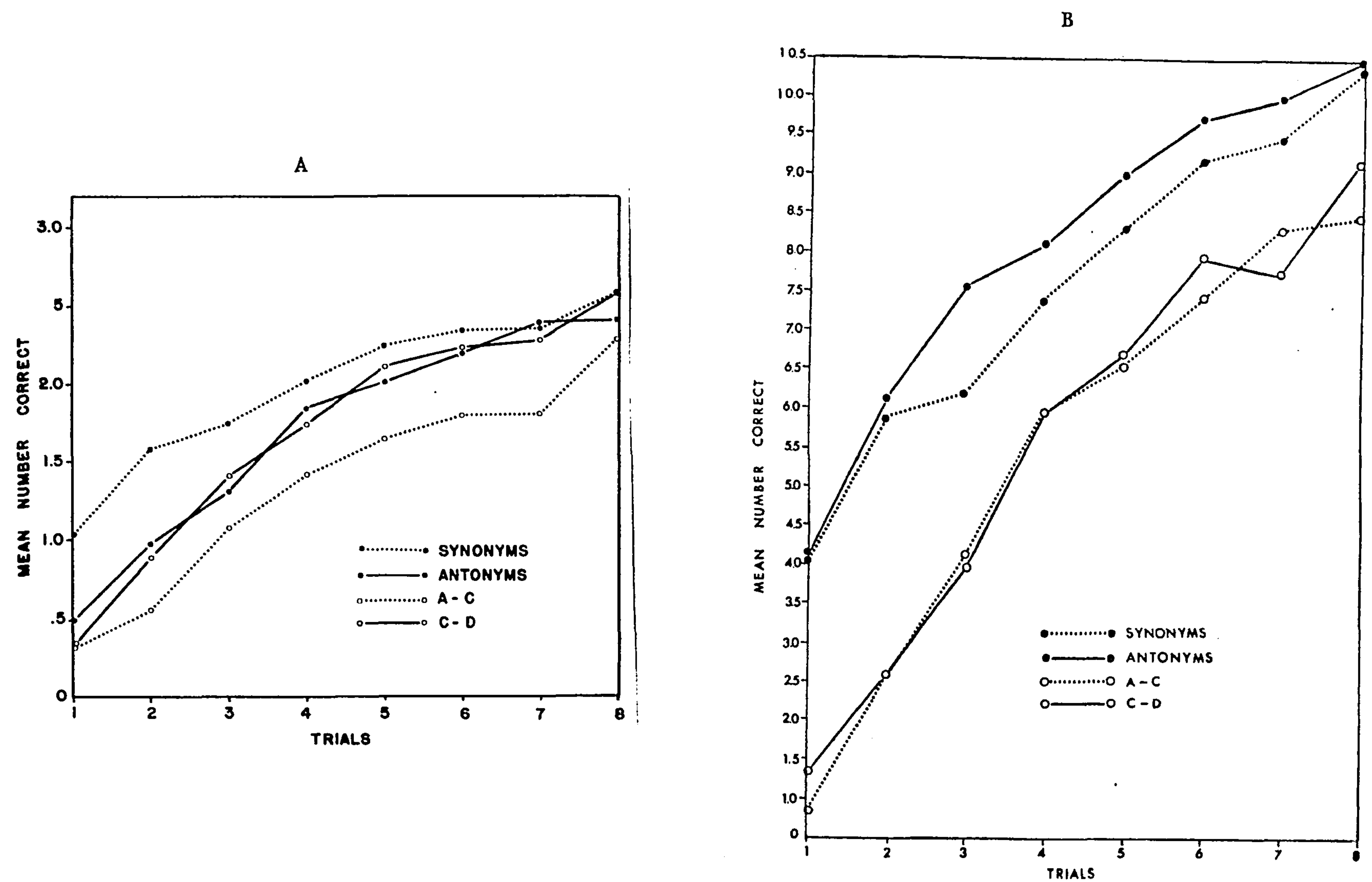

Figure 2-3 Acquisition across the first eight trials in mixed (A) and unmixed list (B) designs. (Wickens & Cermack, 1967)

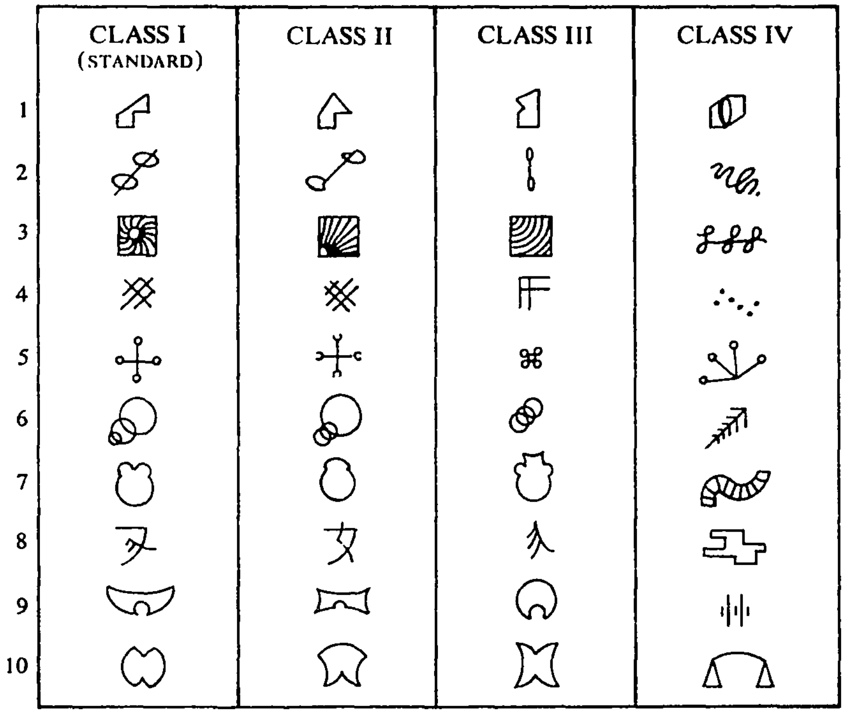

Figure 3-1 Stimulus forms grouped in classes as a function of their similarity to the standard. (Gibson, 1941)

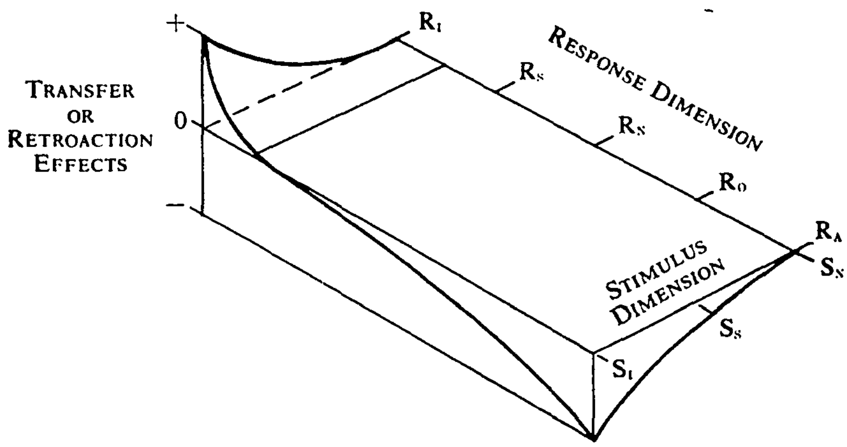

Figure 3-2 The transfer and retroaction surface: medial plane represents transfer effects of zero magnitude. Response relations distribute along the length of the solid and stimulus relations along the width. (Osgood, 1949)

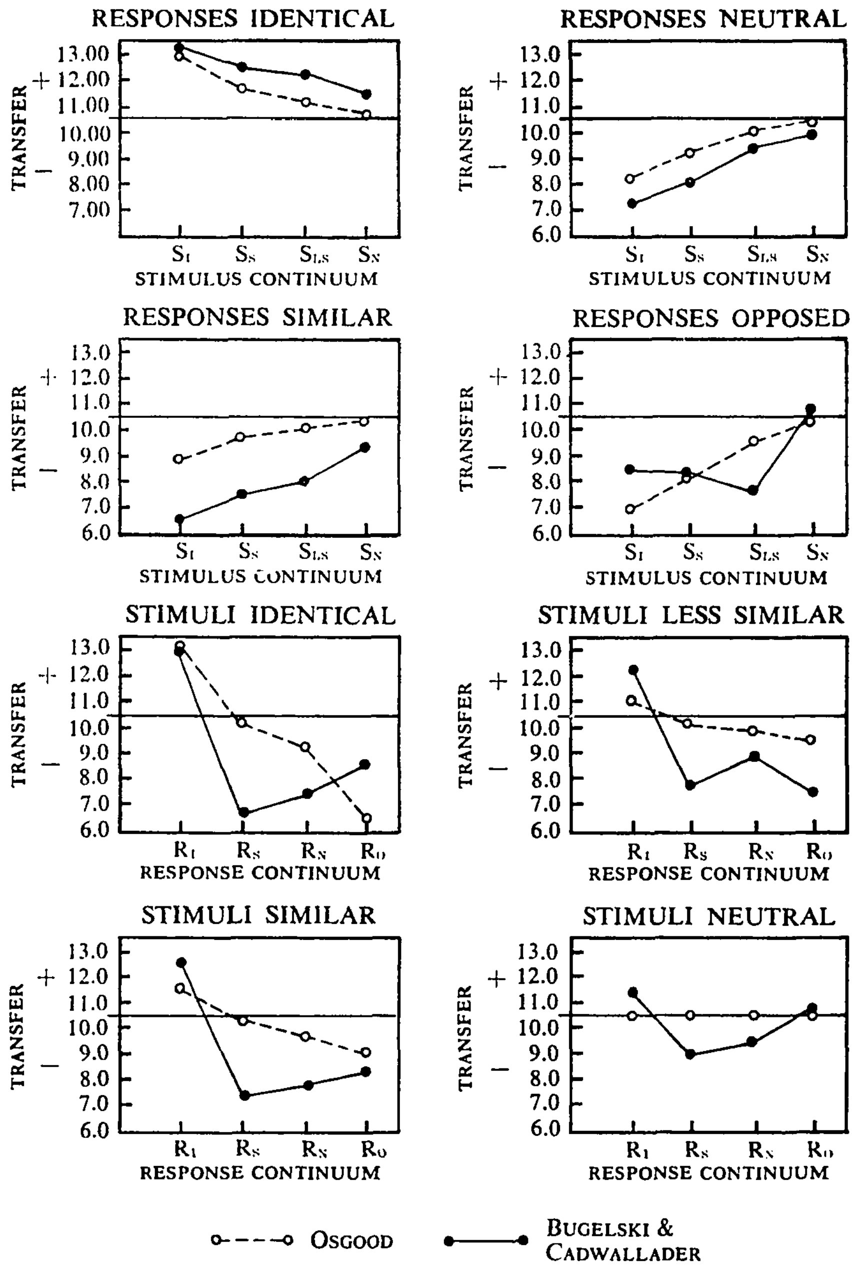

Figure 3-3 The experimental findings of Bugelski and Cadwallader (1956) compared with Osgood's theoretical values. (Hall, 1971)

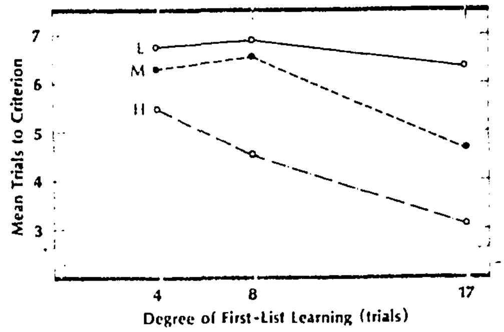

Figure 3- 4 Mean trials to a criterion of 7/12 during transfer as a function of interlist response similarity (L, M, or H) and degree of first-list learning. (Underwood, 1951)

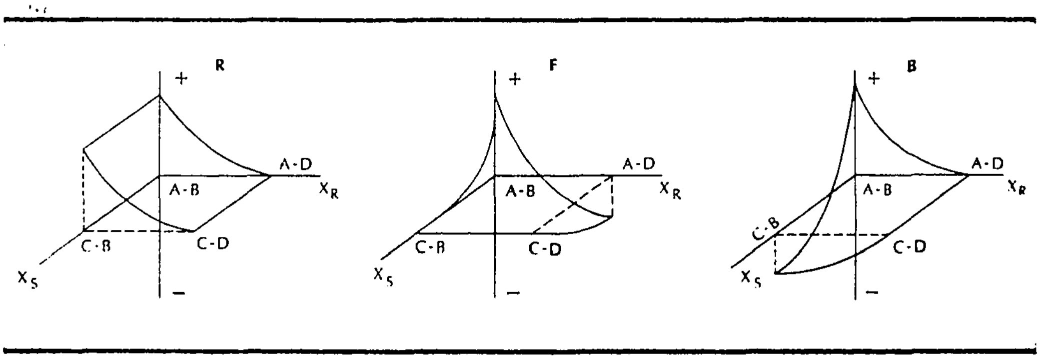

Figure 3-5 Component surfaces for response availability (R), forward associative learning (F), and backward associative learning (B). Degree of stimulus similarity is represented along the X_S axis, and degree of response similarity along the X_R axis. (Martin, 1965)

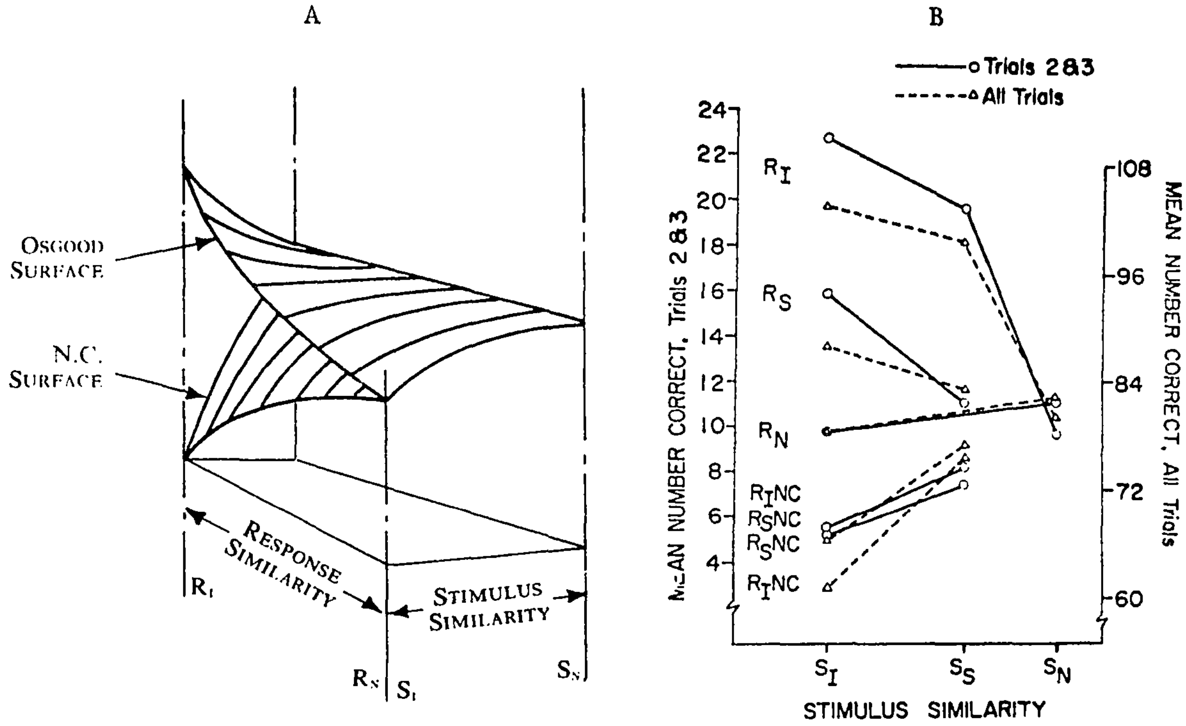

Figure 3-6 (A) The Osgood (1949) transfer surface and a proposed surface for noncorresponding paradigms. (B) Mean number of correct responses on Trials 2 & 3 (solid lines and circles) and on all trials (dashed lines and triangles) as a function of interlist similarity. (Dallett, 1965)

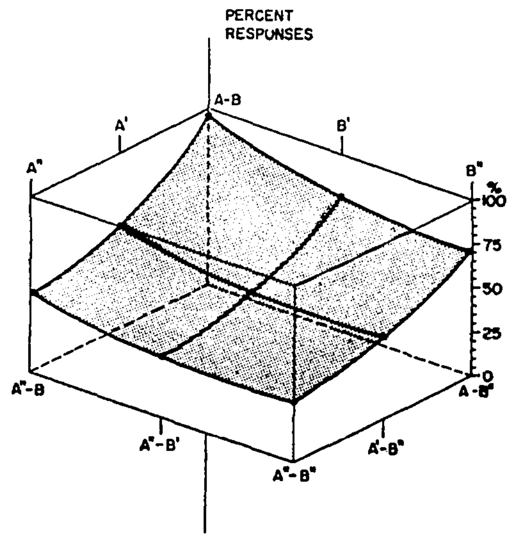

Figure 3-7 Percentage of correct responses as a function of degree of stimulus and response similarity. (Shea, 1969)

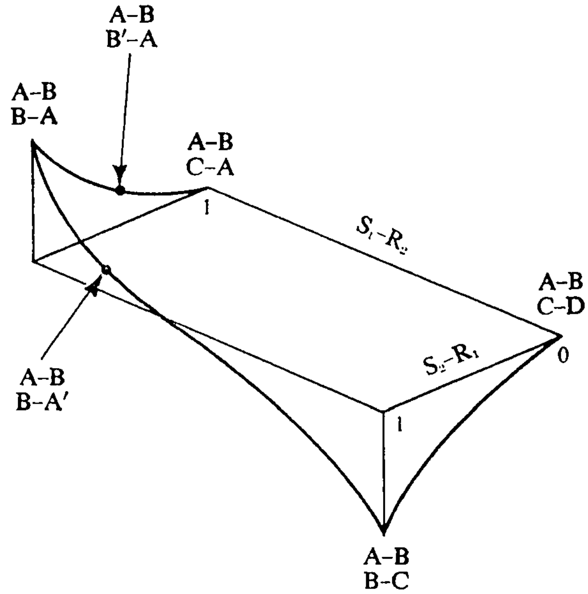

Figure 3-8 Transfer as a function of S_1-R_2 and S_2-R_1 similarity. (Houston, 1964)

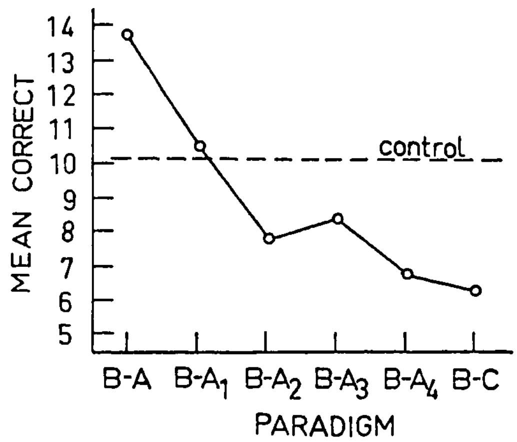

Figure 3-9 Mean correct responses on trials 1 and 2 during second list acquisition. (Houston, 1966b)

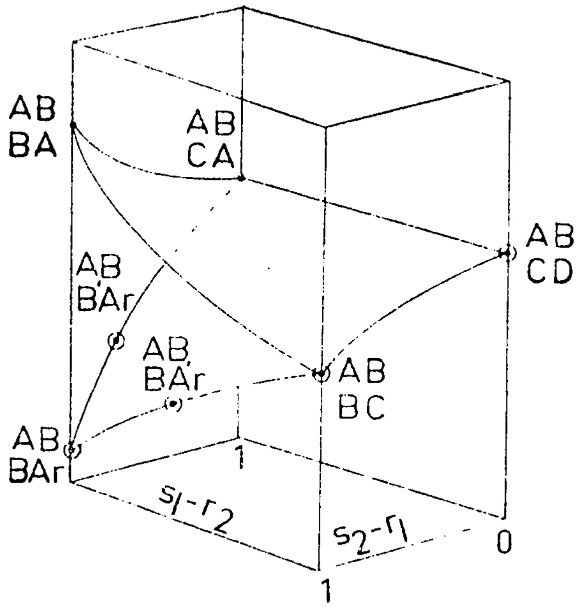

Figure 3-10 The Houston (1964) surface and a proposed noncorresponding transfer surface. (Houston, 1965)

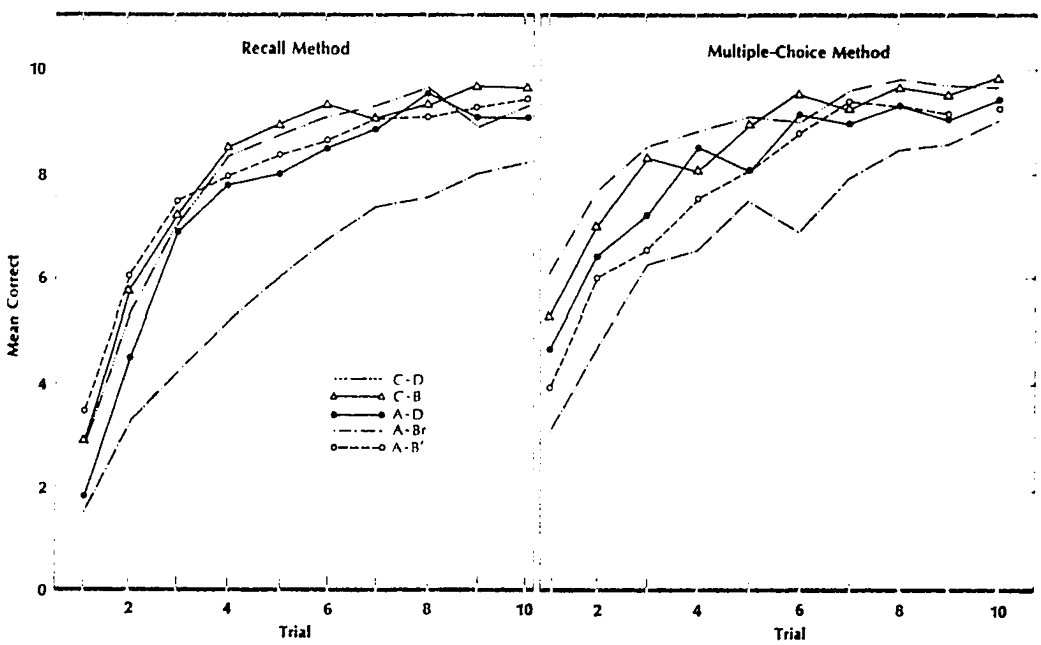

Figure 4-1 Transfer acquisition as a function of paradigm and recall or multiple-choice methods. (Postman & Stark, 1969)

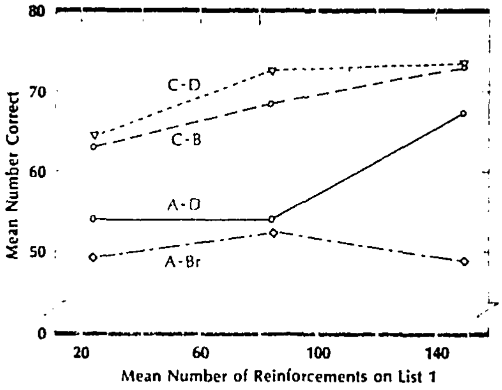

Figure 4-2 The effect of degree of first-list learning on transfer using paired adjective materials. Degree of learning is scaled in terms of the number of correct anticipation (reinforcement) during first-list acquisition. (Postman, 1962)

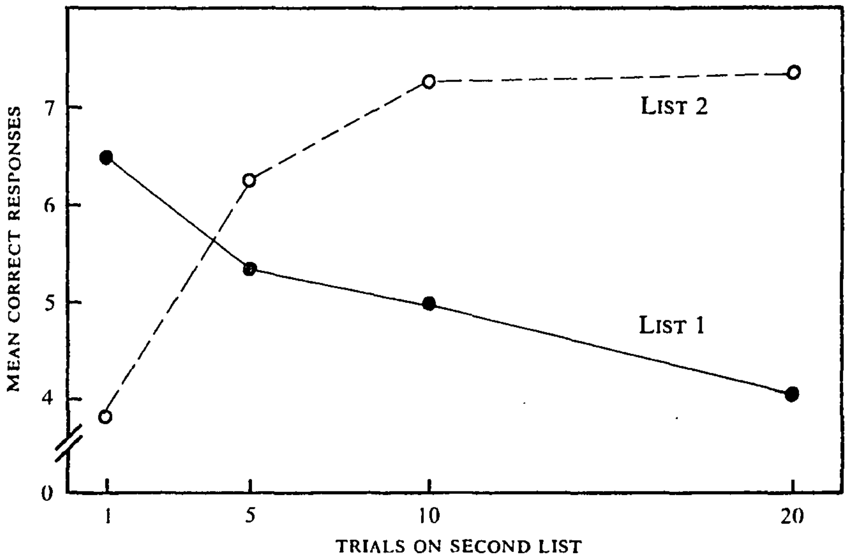

Figure 4-3 Mean number of responses correctly recalled and identified with stimulus and list in the A-B, A-C paradigm. (Barnes and Underwood, 1959)

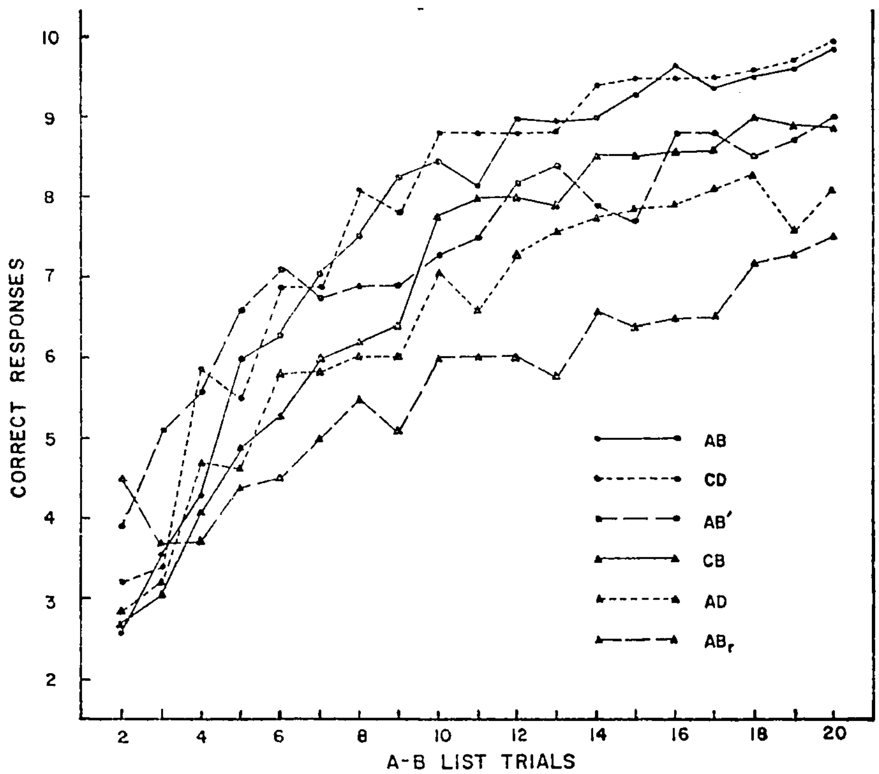

Figure 4-4 Acquisition performance on the A-B list with practice alternating on one of six different paradigms. (Crouse, 1968)

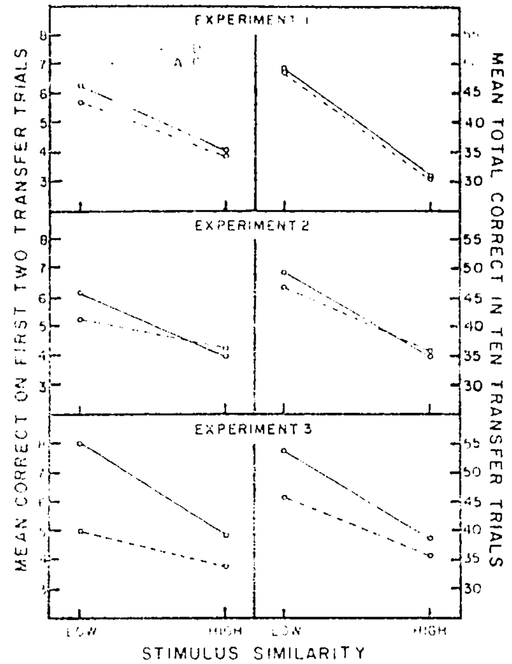

Figure 4-5 Mean number of correct responses on the first two transfer trials (left) and on all ten transfer trials (right) as a function of paradigm and stimulus similarity. (Underwood & Ekstrand, 1968)

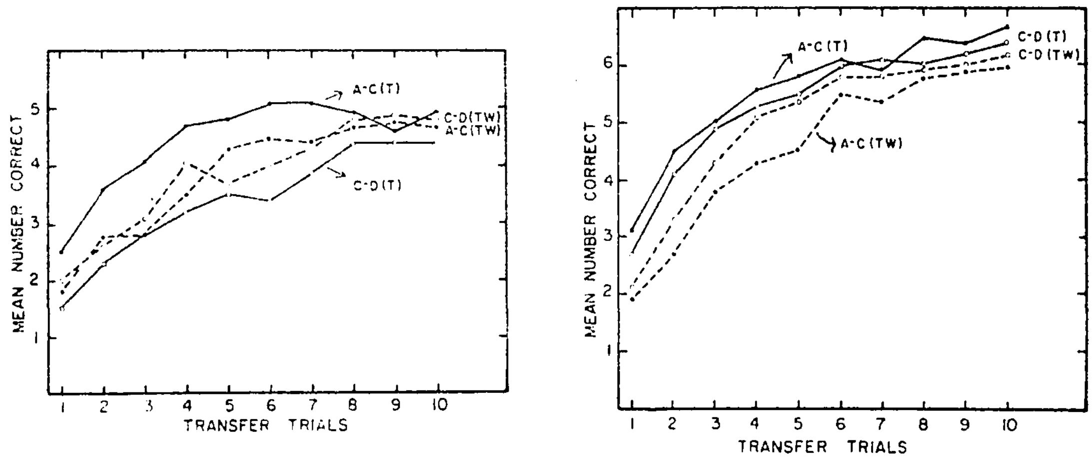

Figure 4-6 Mean number of correct responses on each transfer trial as a function of paradigm and type of free-learning for Experiment I and Experiment II. (Underwood & Freund, 1968)

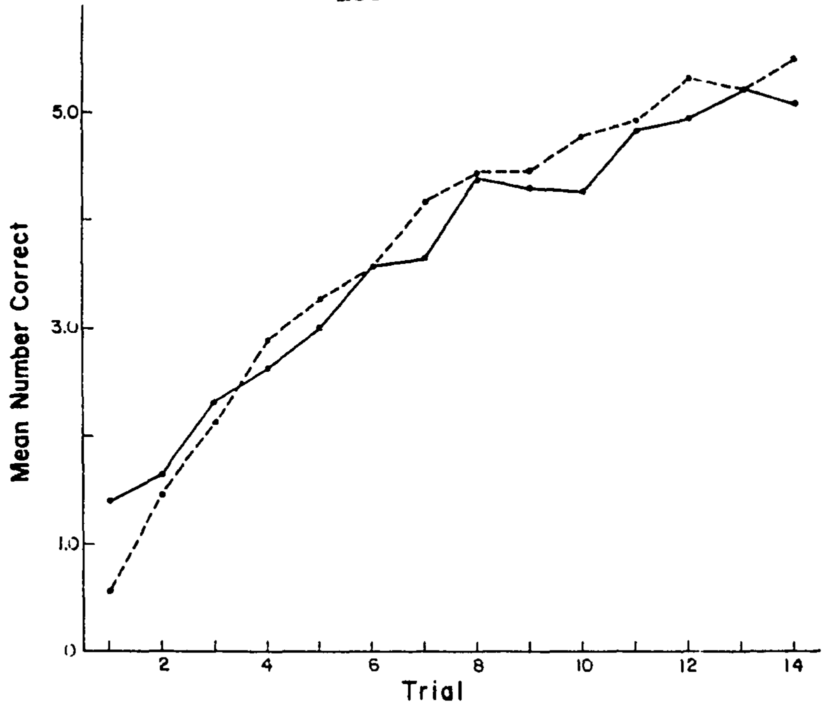

Figure 4-7 Mean number of correctly placed responses as a function of interpolated learning trials for the two conditions C-B (———) and C-D (------). (Johnston, 1968)

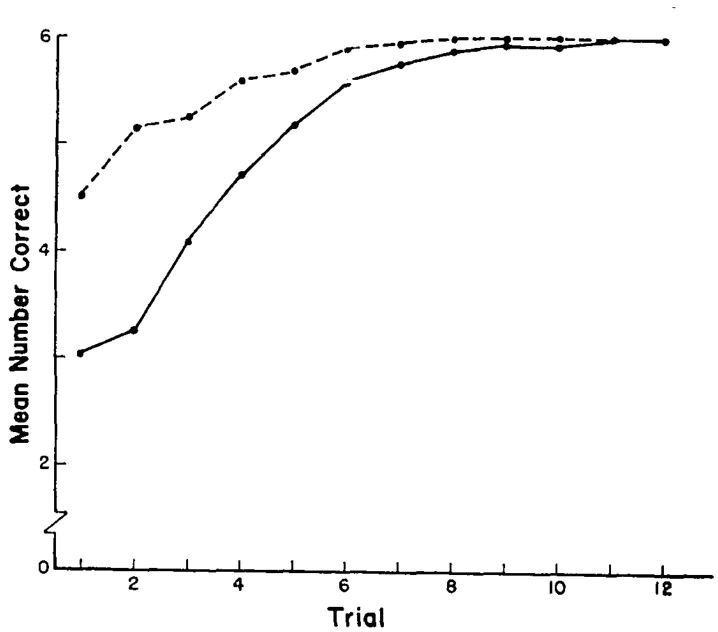

Figure 4-8 Mean number of correctly placed responses as a function of C-B (———) and C-D (----) interpolated learning. (Johnston, 1968)

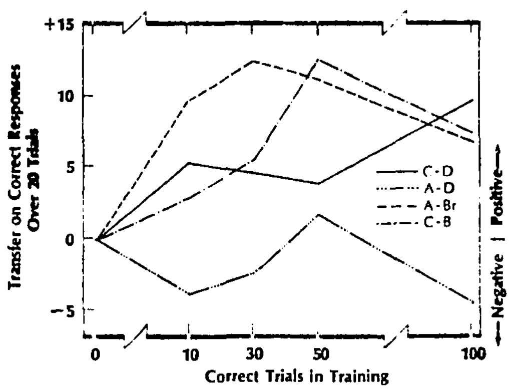

Figure 4-9 Transfer performance as a function of the degree of first list learning. (Mandler & Heinemann, 1956)

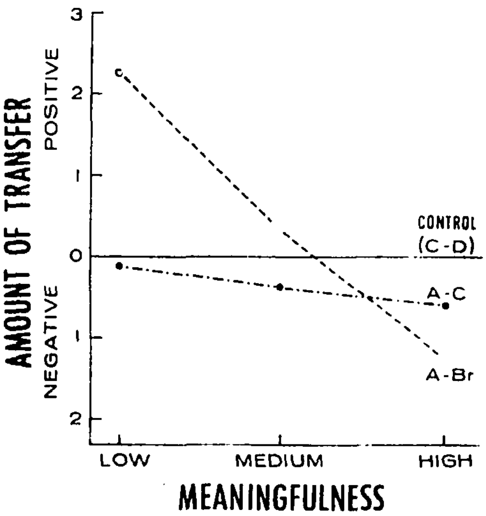

Figure 4-10 Amount of transfer for the A-B_r and A-C paradigms, at each level of meaningfulness, as measured by difference from control (C-D) paradigm in mean total errors per pair. (Merikle & Battig, 1963)

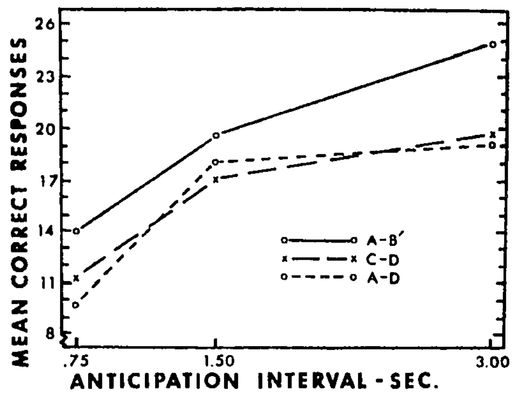

Figure 4-11 Mean total correct responses on the first five trials of A-B learning. (Richardson, 1967a)

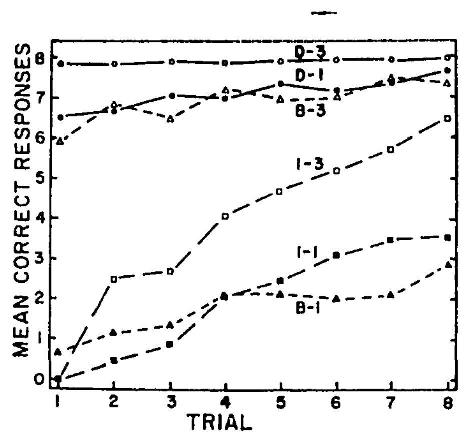

Figure 4-12 Mean number of correct responses on each trial of S-D learning. The first symbol in each label indicates the type of first-list responses and the second indicates either a 1- or 3-sec anticipation interval on the S-D list. (Richardson, 1967b)

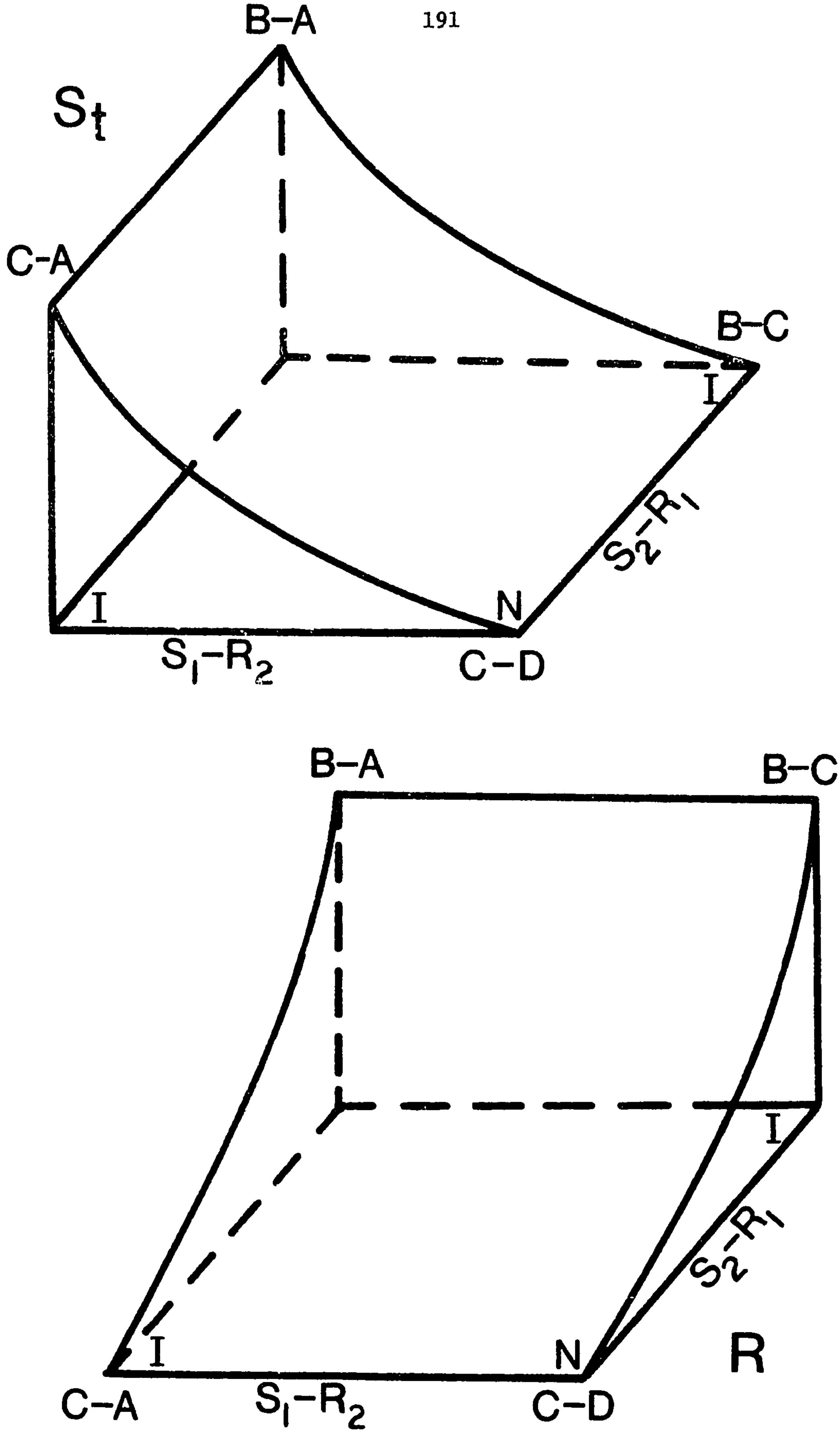

Figure 5-1 St and R component surfaces in S_1-R_2, S_2-R_1 transfer.

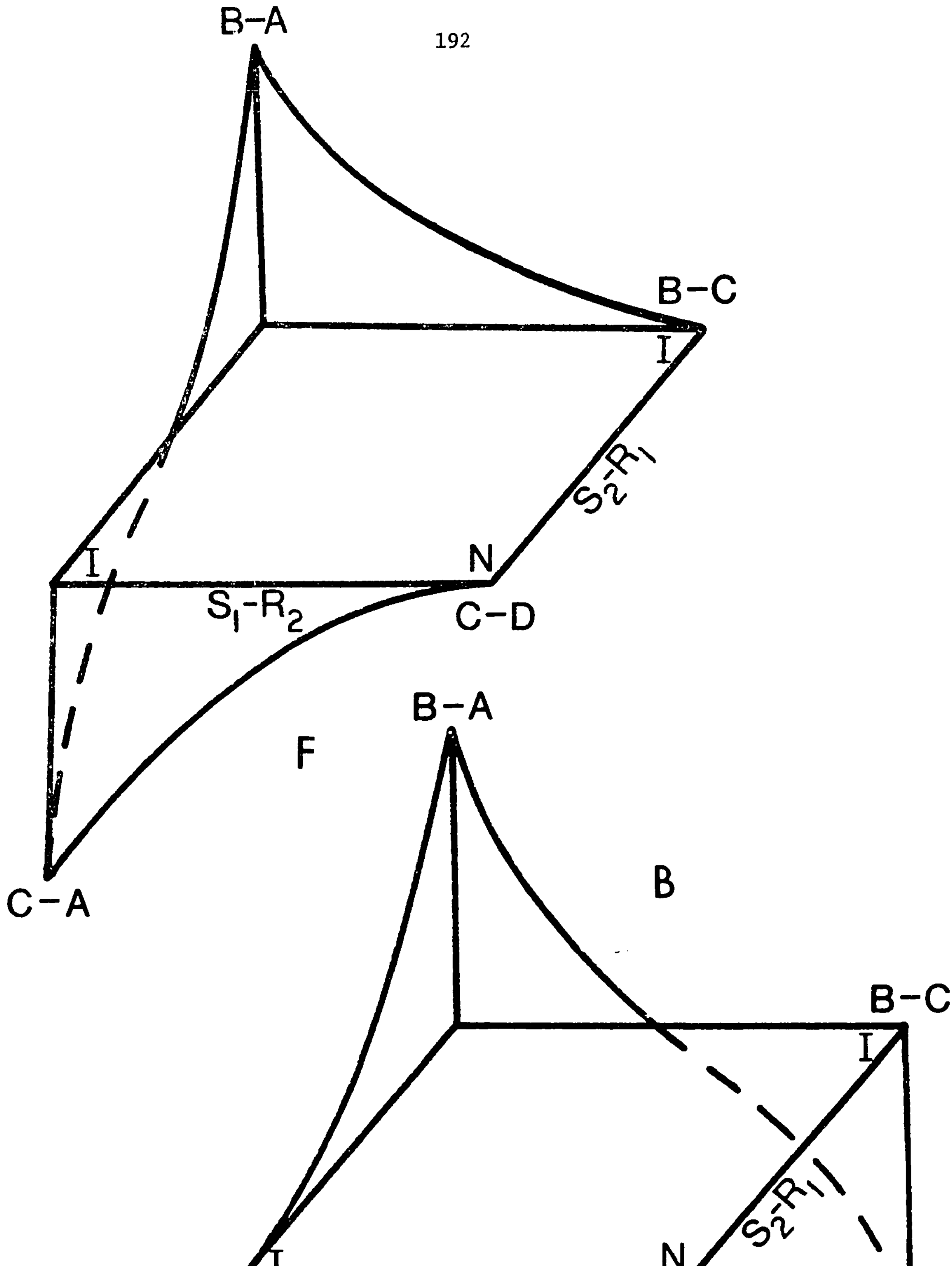

Figure 5-2 F and B component surfaces in S_1-R_2, S_2-R_1 transfer.

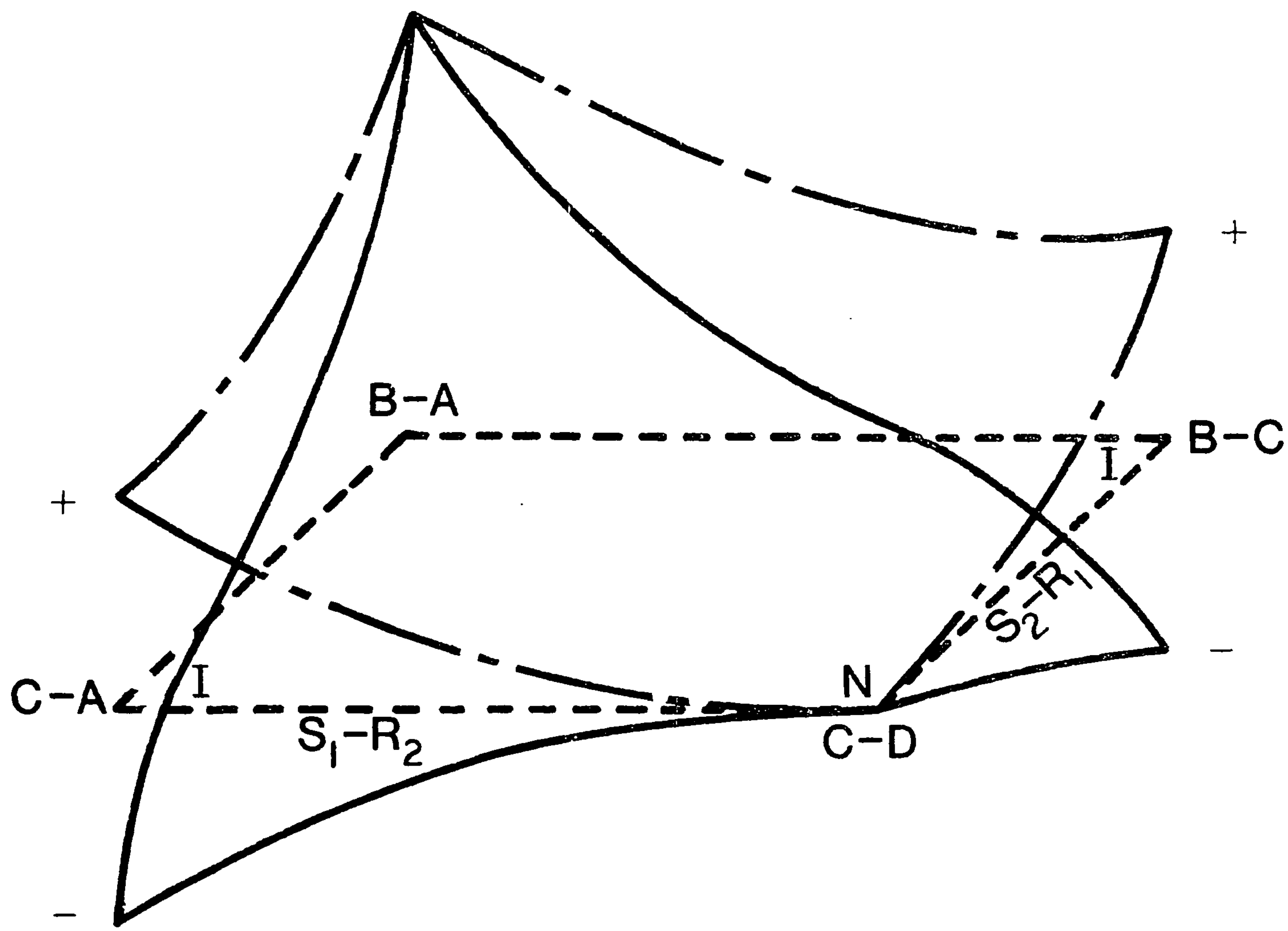

Figure 5-3 Net transfer surfaces for the S_1-R_2, S_2-R_1 paradigms predicted from interactions with relevant secondary variables, degree of first list learning and meaningfulness.

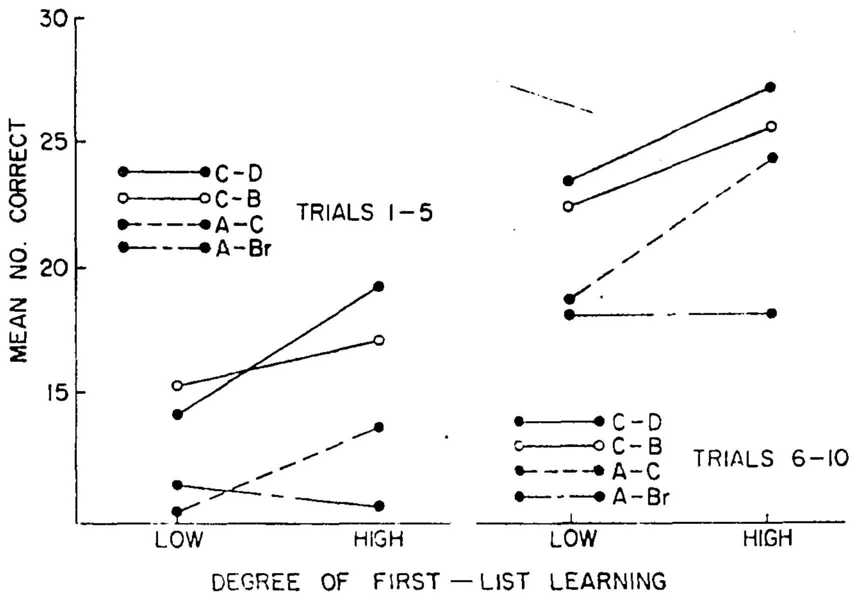

Figure 6-1 Mean number of correct anticipations on List-2 as a function of degree of first-list learning and paradigm. (Jung, 1962)

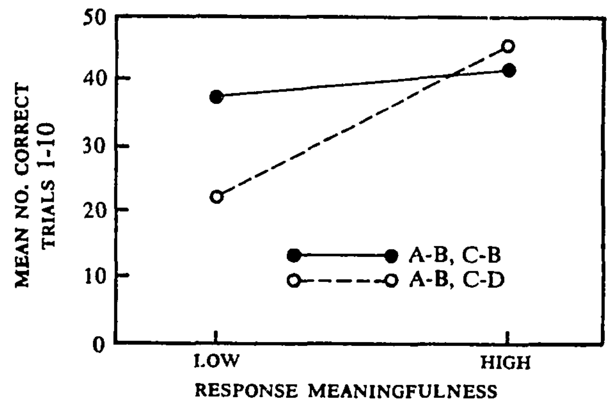

Figure 6-2 Mean number of correct responses as a function of response meaningfulness. (Jung, 1963)

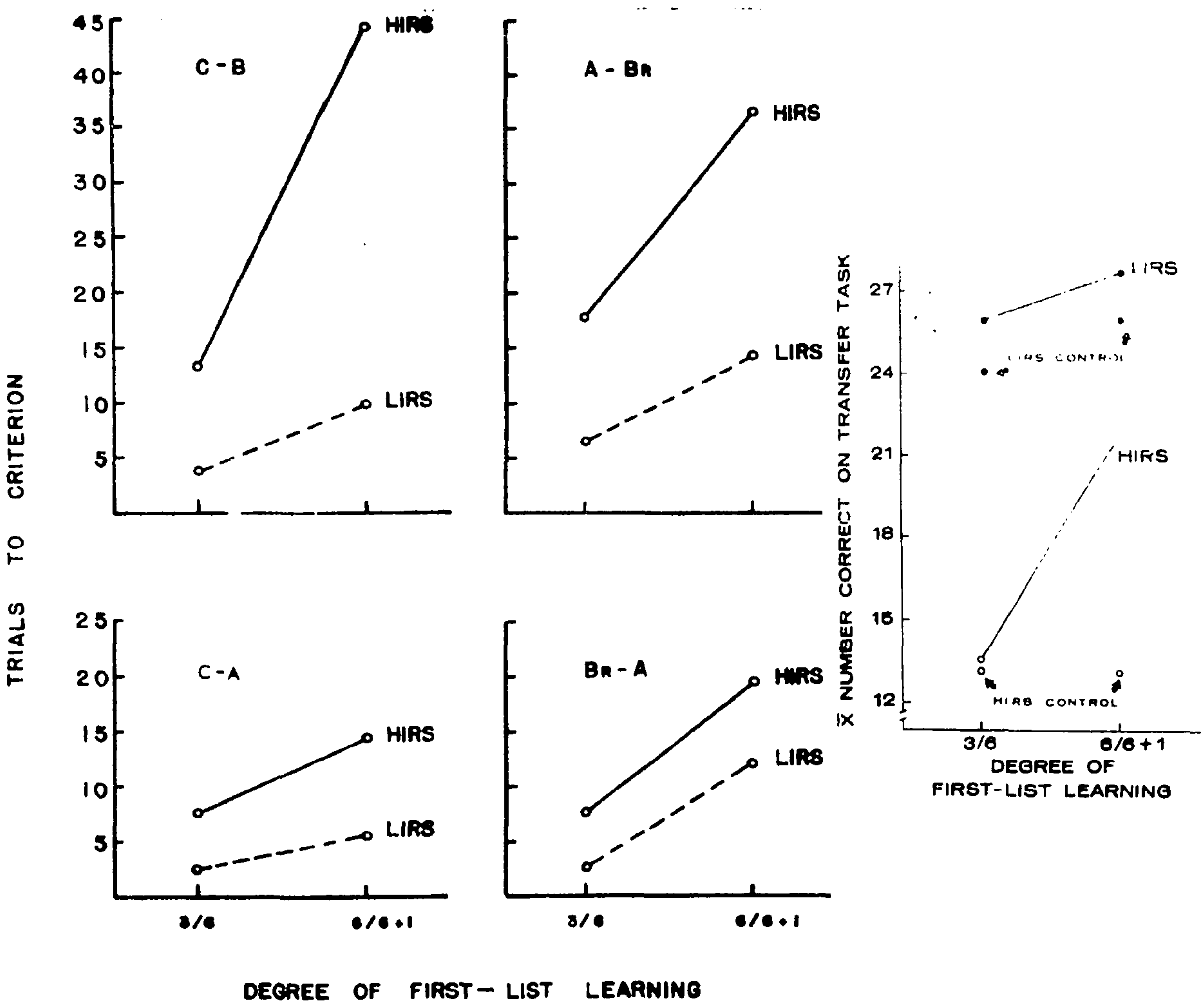

Figure 6-3 The mean number of trials to the particular first-list acquisition criterion for the various paradigms and similarity conditions (left) and the mean number of correct responses on the 10 transfer trials (right) as a function of degree of first-list learning (DOL) and inter-response similarity (IRS). (Homzie, Weimer, Schwartz, and Waters, 1969)

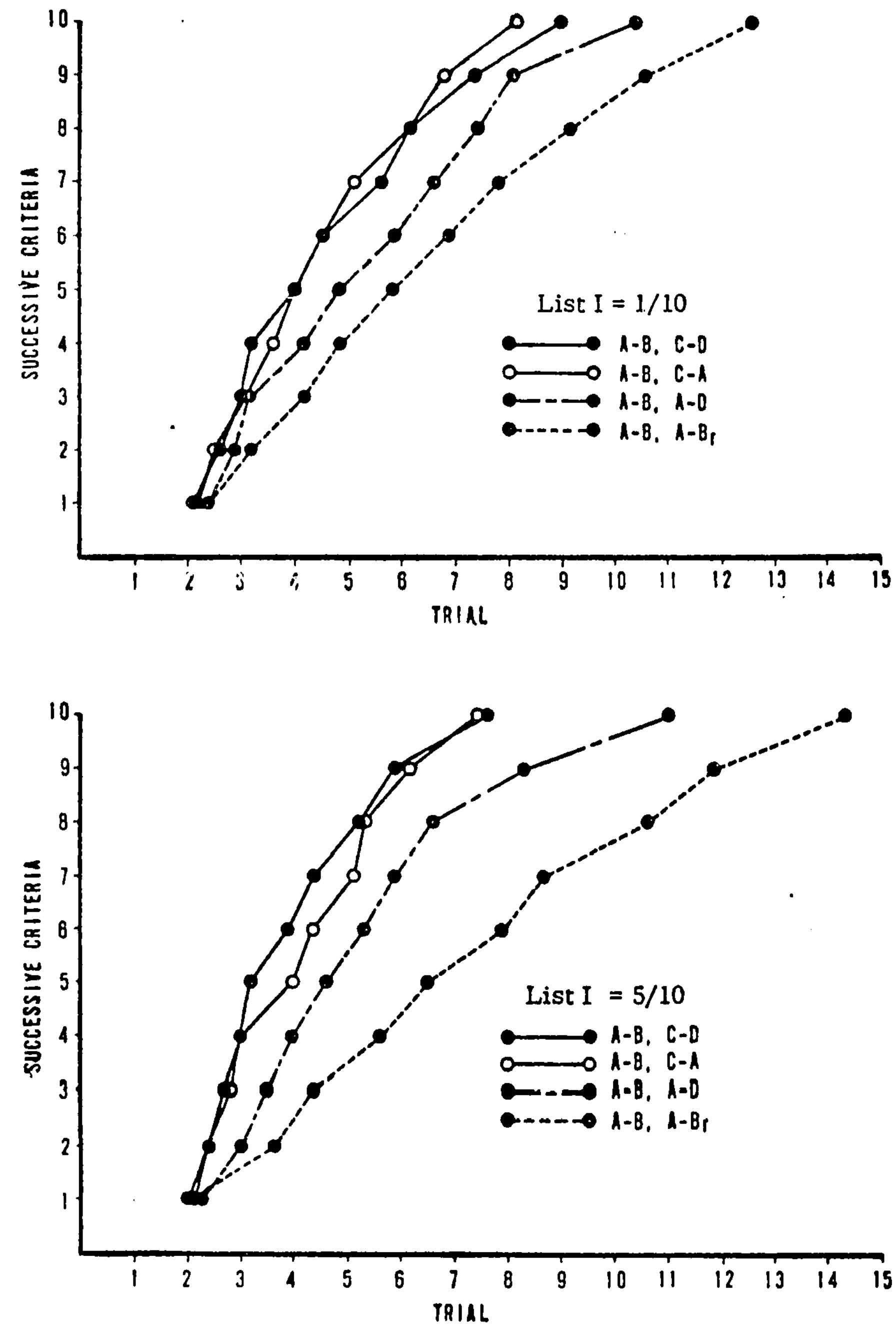

Figure 6-4 Mean trials to reach successive criterion in List 2 learning after reaching a List 1 criterion of 1/10 (top) or 5/10 (bottom). (Schulman, 1967)

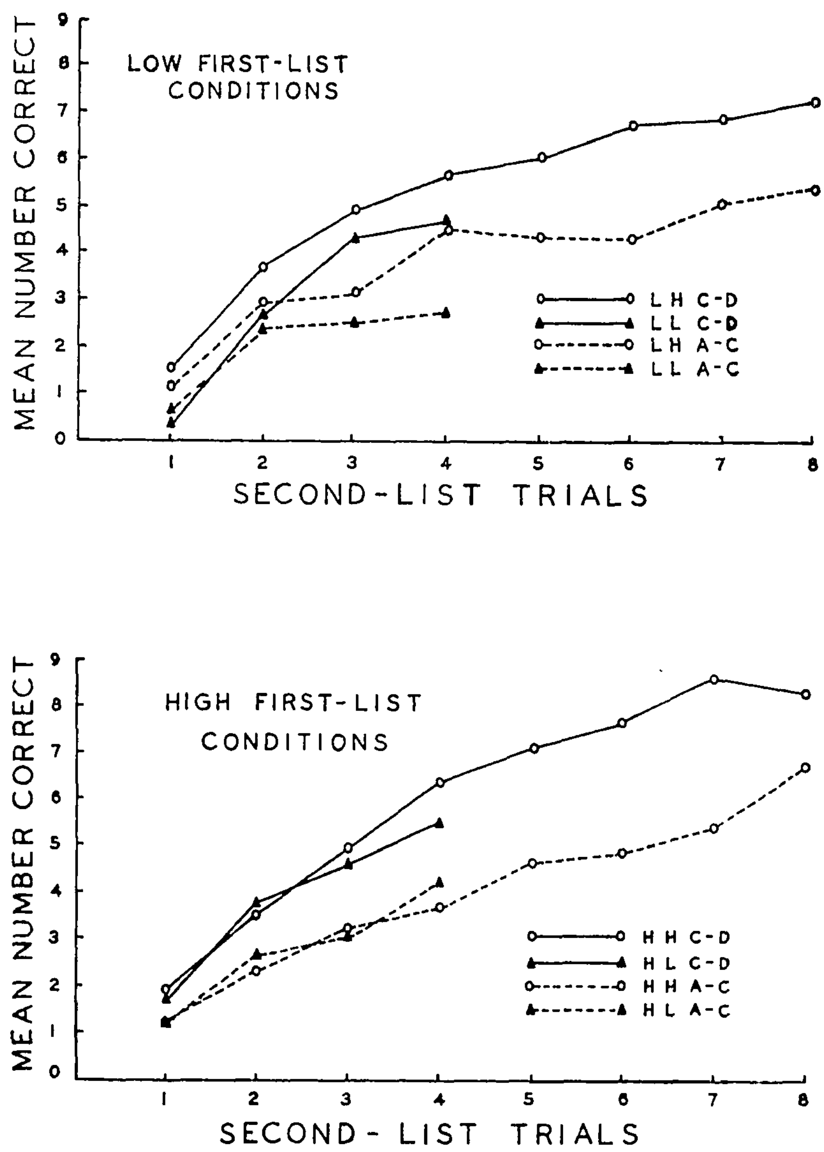

Figure 6-5 Mean number correct on each transfer trial for conditions receiving a low degree of first-list learning (top) or a high degree of first-list learning (bottom). (Jung, 1967)

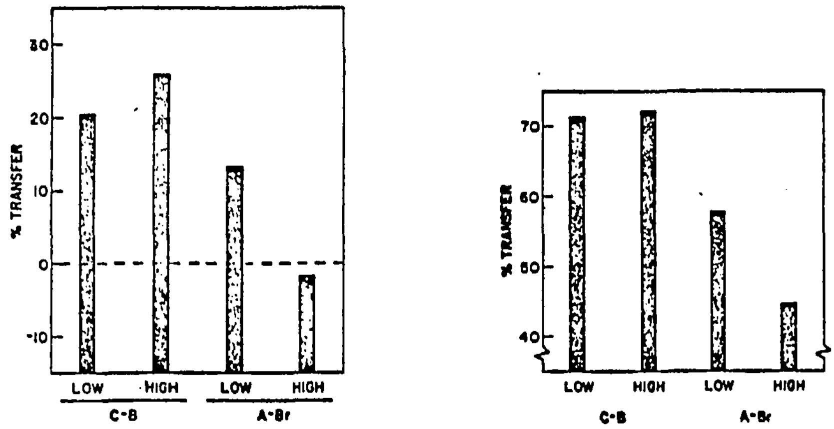

Figure 6-6 Mean percent of transfer from Task 1 to Task 2 (left) and mean percent of transfer from Task 1 to Task 3 (right). (Martin, 1968)

APPENDIX C

PROSPECTUS TABLES

TABLE 1-1

SEQUENCE OF EXPERIMENTAL EVENTS USED TO MEASURE THE EFFECT OF 0, 2, 4, 6, 8, AND 10 PA LEARNING TRIALS UPON SUBSEQUENT PA LEARNING. (Thune, 1950)

	Day 1			Day 2		
Condition	Practice List	Rest	List A	List A	Cartoon Sorting	List B
0	6 trials	1′	10 trials	0 trials	10′	10 trials
2	6 trials	1′	8 trials	2 trials	10′	10 trials
4	6 trials	1′	6 trials	4 trials	10′	10 trials
6	6 trials	1′	4 trials	6 trials	10′	10 trials
8	6 trials	1′	2 trials	8 trials	10′	10 trials
10	6 trials	—	—	10 trials	10′	10 trials

TABLE 1-2

SECOND-LIST MEANS FOR TOTAL TRIALS, TOTAL ERRORS, AND-FOR CONDITIONS SD AN DD-THE NUMBER OF WITHIN-PAIR STIMULUS LETTERS ERRONEOUSLY GIVEN AS RESPONSE LETTERS (PS) CONVERTED TO PERCENTAGE OF TOTAL ERRORS (Thompson & Fritzler, 1968)

	Condition[a]			
	DD	SS	DS	SD
Errors	27.2	35.6	46.7	59.1
Trials	8.8	10.8	14.4	14.6
PS (%)	.90			3.40

[a] Means underlined with the same line do not differ significantly.

TABLE 1-3

MEAN NUMBER OF TRIALS TO CRITERION AND OF CORRECT RESPONSES ON FIRST TEN TRANSFER TRIALS (Postman & Schwartz, 1964)

Acquisition of Paired-Associate Test List		Acquisition of Serial Test List	
Condition	Mean Trials to Criterion	Condition	Mean Trials to Criterion
Control	16.75	Control	15.50
PA(A)-PA(A)	7.38	S(A)-S(A)	9.31
PA(T)-PA(A)	9.62	S(T)-S(A)	9.75
S(A)-PA(A)	11.25	PA(A)-S(A)	12.44
S(T)-PA(A)	13.00	PA(T)-S(A)	11.44

TABLE 1-4

MEAN NUMBERS OF CORRECT RESPONSES IN TEN TRIALS OF LIST-2 LEARNING (Postman, Keppel, & Zacks, 1968)

	Condition	
Treatment	E	C
H-H	41.6	37.2
L-H	47.4	40.7
L-L	31.1	23.4
H-L	29.8	24.6

TABLE 2-1

MEAN NUMBERS CORRECT AND PERCENTAGES OF TRANSFER FOR UNMIXED (UL) AND MIXED (ML) DESIGNS ON THE FIRST TRANSFER TRIAL. (Postman, 1966)

	UL		ML	
Paradigm	Mean	% Transfer	Mean	% Transfer
C-D	3.0		2.6	
A-C	1.3	−39.5	1.1	−40.5
C-B	3.3	+ 4.8	2.2	− 8.3
A-B′	5.3	+31.5	4.0	+21.2

TABLE 2-2

SUMMARY OF THE RESULTS OF EXPERIMENT II: CRITERIA OF TRIALS TO LEARN AND NUMBER OF TRIALS TO LEARN AND NUMBER OF CORRECT RESPONSES IN EIGHT TRIALS (Wickens & Cermak, 1967)

Criterion	Synonym	Antonym	A-C	C-D
(1) Mean Trials to Learn				
Unmixed	4.00	3.31	5.82	5.80
Mixed	3.27	5.40	5.98	4.97
(2) Percent Transfer				
Unmixed	31%	43%	−3%	
Mixed	34%	−9%	−20%	
(3) Mean Correct/8 Trials				
Unmixed	5.39	5.43	3.85	3.67
Mixed	5.23	4.82	3.62	4.27
(4) Percent Transfer				
Unmixed	47%	48%	4%	
Mixed	22%	13%	−15%	

TABLE 3-1

COVARIANCE-ADJUSTED MEAN NUMBER OF TRIALS TO LEARN TRANSFER LIST CATEGORIZED BY STIMULUS AND RESPONSE SIMILARITY RELATION: TO PRIOR LISTS (Wimer, 1964)

Stimulus relations	Response similarity relations				
	Identical	Similar	Unrelated	Opposed	Antonym
Identical	1.9+	9.5	11.3−	8.8	8.1+
Similar	7.1+	7.8+	9.2	6.3+	7.7+
Unrelated	10.0	9.2	*9.6*	8.3	9.9
Opposed	8.6	9.7	9.6	7.6+	6.8+
Antonym	10.0	8.2	10.0	7.8+	6.7+

[a] Plus and minus signs are used to indicate the direction of transfer suggested by the difference from the control group (italic).

TABLE 3-2

PREDICTED AND OBSERVED PERCENTAGES FOR THE SIMULTANEOUS GENERALIZATION PARADIGMS. (Shea, 1969)

Exp.	Paradigm	Predicted percentage correct	Observed percentage correct
I	A′-B′	47.2	45.8
	A′-B″	41.7	54.2
	A″-B′	36.1	37.5
	A″-B″	31.9	25.0
II	A′-B′	38.9	47.2
	A′-B″	38.9	40.3
	A″-B′	33.3	31.9
	A″-B″	33.3	43.1

TABLE 3-3

TRANSFER AS A FUNCTION OF S_1-R_2, S_2-R_1 SIMILARITY. MEAN NUMBER OF CORRECT RESPONSES ON FIRST TRIAL OF LIST-2. (Houston, 1966a)

	S_1-R_2 Identical		S_1-R_2 Similar		S_1-R_2 Neutral	
	M	*SD*	*M*	*SD*	*M*	SD
	A-B, B-A		A-B, B-A′		A-B, B-C	
S_2-R_1 Identical	7.13	.84	4.13	2.00	1.00	.93
	A-B, B′-A		A-B, B′-A′		A-B, B′-C	
S_2-R_1 Similar	5.50	1.61	3.13	1.55	2.75	1.75
	A-B, C-A		A-B, C-A′		A-B, C-D	
S_2-R_1 Neutral	3.00	1.20	4.00	1.61	3.25	1.39

TABLE 4-1

TOTAL CORRECT RESPONSES ON A-B LIST AS A FUNCTION OF ALTERNATING PRACTICE ON ONE OF FIVE PARADIGM LISTS. (Crouse, 1968)

		Mean difference				
Paradigm	Total correct	AB	AB′	CB	AD	AB_r
CD	149.70	3.35	10.20	18.15	27.00*	43.50†
AB	146.35		6.85	14.80	23.65*	40.15†
AB′	139.50			7.95	16.80	33.30†
CB	131.55				8.85	25.35*
AD	122.70					16.50
AB_r	106.20					

Note.—MS_{wg} = 1058.94.
* $p < .05$, Duncan's multiple-range test.
† $p < .01$, Duncan's multiple-range test.

TABLE 4-2

MEAN CORRECT RESPONSES ON TRIALS 1-4 AND MEAN CORRECT RESPONSES ON THE MFR TEST. (Goulet & Behar, 1966)

			List 1 Practice Unidirectional	Bidirectional
Paradigm	A-B, A-C	E	4.50	5.25
		C	7.38	7.12
	A-B, C-B	E	6.50	6.56
		C	8.25	9.44

			List 1 Practice Unidirectional	Bidirectional
Paradigm	A-B, A-C	E	3.19	3.12
		C	3.69	3.75
	A-B, C-B	E	1.44	3.12
		C	2.56	3.75

TABLE 4-3

MEANS AND SDs FOR CORRECT RESPONSES IN THE TRANSFER TASK. (Saravo & Price, 1967)

		Similarity							
Paradigm	Form	High		Medium		Low		Mean	SD
		Mean	SD	Mean	SD	Mean	SD		
	1	5.9	4.53	8.1	4.38	9.1	7.03		
A-B, A-Br	2	8.3	2.31	7.0	4.92	6.1	5.40	7.3	4.65
	3	7.0	3.52	7.7	3.68	11.8	3.36		
	M	7.1	3.59	7.6	4.23	9.0	5.78		
	1	6.5	3.52	8.7	4.21	8.2	3.45		
A-B, A-C	2	7.1	2.96	8.6	4.71	8.9	5.04	7.5	4.11
	3	6.8	5.07	6.4	3.97	6.6	4.14		
	M	6.8	3.87	7.9	4.30	7.9	4.22		
	1	13.8	2.05	12.1	4.65	12.2	4.98		
A-B, C-D	2	5.8	3.91	8.8	5.05	7.2	4.21	10.8	5.21
	3	13.6	4.90	11.3	4.85	13.2	5.53		
	M	11.0	5.41	10.7	4.07	10.9	5.46		
	TOT	24.9	8.30	26.2	9.67	27.7	12.44		

TABLE 4-4

PERCENT OCCURRENCE OF OMISSIONS AND MISPLACEMENTS AS A FUNCTION OF INTERPOLATED LEARNING CONDITION AND TRIAL BLOCKS. (Johnston, 1968)

		Trial blocks	
Error	Condition	2-8	9-15
Omissions	C-B	67.9	50.6
	C-D	87.7	67.8
Misplacements	C-B	31.2	49.0
	C-D	10.6	31.3

TABLE 4-5

MEAN NUMBER CORRECT ON EACH RE-LEARNING TRIAL FOR EACH CONDITION. (Johnston, 1968)

		RL trial	
IL	RL	1	2
C-B	A-B	3.38	4.50
	B-A	3.06	3.94
C-D	A-B	4.56	4.81
	B-A	3.75	4.69

TABLE 4-6

SUMMARY DATA FOR LIST 1 TRIALS AND LIST 2 CORRECT RESPONSES. (Olivier & Kausler, 1967)

Condition	Measure			
	List 1 Trials		List 2 Correct Responses	
	Mean	SD	Mean	SD
Group C	12.20	5.88	55.20	9.63
Group E1	15.27	8.75	44.13	14.75
Group E2	10.33	8.75	50.73	9.78
Group E3	6.00	1.73	49.73	13.18

TABLE 4-7

THE MEAN NUMBER OF CORRECT RESPONSES ON THE FIRST FIVE TRANSFER TRIALS. (Richardson, 1968)

Instructions	AI	A-BA		A-BS		C-D	
		$\bar{X}$	σ	$\bar{X}$	σ	$\bar{X}$	σ
Standard	1 sec	13.50	5.26	16.38	7.46	11.50	2.88
	3 sec	32.00	9.50	34.88	4.85	17.62	10.41
Specific	1 sec	12.50	6.99	14.62	6.41	7.00	4.28
	3 sec	35.00	2.51	38.75	5.34	21.75	9.50

TABLE 5-1

THE HYPOTHESIZED RELATIVE CONTRIBUTION OF EACH COMPONENT PROCESS IN BOTH THE S_1-S_2, R_1-R_2 AND S_1-R_2, S_2-R_1 PARADIGMS.

	R k	F	B	Net Transfer
C-D	0	0	0	0
A-B	+	+	+	+ only
A-C	0	-	0	- only
C-B	+	0	-	varies + to -

	ST	R	F	B	Net Transfer
C-D	0	0	0	0	0
B-A	+	+	+	+	+ only
C-A	+	0	-	0	varies + to -
B-C	0	+	0	-	varies + to -

TABLE 6-1

MEAN CORRECT LIST-2 RESPONSES. (Goulet, 1965)

Paradigm	Response M Combinations			
	H_1-H_2	H_1-L_2	L_1-L_2	L_1-H_2
Trials 1–5				
A-B, A-C				
M	7.93	2.53	5.00	14.67
SD	6.36	3.23	3.81	6.46
A-B, C-D				
M	13.27	4.87	6.20	12.40
SD	4.47	4.33	3.53	5.85
Mean Difference (A-C − C-D)	−5.34	−2.34	−1.20	+2.27
Trials 1–15				
A-B, A-C				
M	68.27	39.93	49.80	85.93
SD	18.37	19.42	17.71	14.00
A-B, C-D				
M	84.93	50.13	59.40	82.47
SD	13.68	15.95	16.48	15.49
Mean Difference (A-C − C-D)	−16.66	−10.20	−9.60	+3.46

TABLE 6-2

PERCENTAGE TRANSFER AND C-D TOTAL ERRORS. (Merikle, 1968)

Paradigm	Meaningfulness Condition			
	H-H	L-H	H-L	L-L
A-Br	−120.00	−15.3	34.1	33.2
A-D	−162.6	−12.5	9.3	1.4
C-B	0.0	7.6	61.4	27.6
C-D	(5.0)	(18.0)	(36.3)	(47.1)

TABLE 6-3

MEAN NUMBER OF CORRECT LIST-MEMBERSHIP IDENTIFICATIONS AS A FUNCTION OF DEGREE OF FIRST-AND SECOND-LIST LEARNING AND PARADIGMS. (Jung, 1967)

Paradigm	Degree of First- and Second-list Learning			
	Low-Low	Low-High	High-Low	High-High
A-B, A-C	16.2	17.4	17.2	16.9
A-B, C-D	16.4	17.0	17.3	17.5

TABLE 6-4

MEANS AND STANDARD DEVIATIONS FOR NUMBER OF TRIALS TO CRITERION ON LIST 2 (Read & Scarlett, 1973)

Transfer paradigm	Condition							
	LL		LH		HL		HH	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
A-C	3.40	1.84	2.22	.92	5.00	1.88	2.22	.52
C-D	4.56	1.03	3.40	1.25	4.30	2.04	2.22	.96

Note. Abbreviations denote low (L) or high (H) levels of meaningfulness for stimulus and response terms in each condition.

TABLE 7-1

MEANS AND STANDARD DEVIATIONS FOR TOTAL LIST 2 ERRORS WITH VARIATIONS IN INTERLIST W AND R RELATIONSHIPS. (Kanak & Dean, 1969)

W_1-W_2 interlist relationship	R_1-R_2 interlist relationship					
	Identical		Associate		Neutral	
	M	*SD*	*M*	*SD*	*M*	*SD*
Identical	1.33	1.07	12.59	8.30	18.17	6.12
Associate	2.58	2.61	14.66	6.21	10.67	4.34
Neutral	3.42	5.19	11.25	4.90	13.33	3.29

TABLE 7-2

MEANS AND STANDARD DEVIATIONS FOR TOTAL LIST 2 ERRORS UNDER CORRESPONDING AND NONCORRESPONDING PAIRING CONDITIONS. (Kanak & Dean, 1969)

Transfer paradigm	Pairings			
	Corresponding		Noncorresponding	
	M	*SD*	*M*	*SD*
W_1-R_1	2.19	2.17	6.00	5.44
W_1'-R_1	2.56	2.48	4.50	5.87
W_1-R_1'	10.69	10.58	15.25	9.90

APPENDIX D

LIST MATERIALS

Second Lists

A-B H *m*

1		2		3		4	
WIG	POD	POD	WIG	WED	GAS	GAS	WED
DAY	PAW	PAW	DAY	RAM	SON	SON	RAM
TOP	GEM	GEM	TOP	TOY	RIG	RIG	TOY
RED	HIT	HIT	RED	SIX	NOW	NOW	SIX
ROT	JAG	JAG	ROT	NUT	LAY	LAY	NUT
PAL	ROW	ROW	PAL	YES	MUG	MUG	YES

A-B L *m*

5		6		7		8	
WUC	SOJ	SOJ	WUC	XAW	ZYS	ZYS	XAW
YEV	ZAJ	ZAJ	YEV	WUX	YAF	YAF	WUX
LYW	QUV	QUV	LYW	QEH	TAS	TAS	QEH
HIW	XEK	XEK	HIW	JIC	XUQ	XUQ	JIC
CIJ	VOH	VOH	CIJ	VYX	GIC	GIC	VYX
VAW	KYZ	KYZ	VAW	ZIY	CEQ	CEQ	ZIY

First Lists

C-D H *m*

9		10		11		12	
VAN	GUT	GUT	VAN	FUN	ZIP	ZIP	FUN
TAR	YET	YET	TAR	HOP	PEN	PEN	HOP
RIB	KEY	KEY	RIB	SIN	JOB	JOB	SIN
NOD	FOX	FOX	NOD	CUP	BED	BED	CUP
FAR	COD	COD	FAR	FIB	SOD	SOD	FIB
GUN	KEG	KEG	GUN	HAS	BAY	BAY	HAS

C-D L m

13		14		15		16	
MUJ	XAB	XAB	MUJ	DEJ	MYP	MYP	DEJ
ZIF	QYG	QYG	ZIF	KIF	YOX	YOX	KIF
NYD	ZOF	ZOF	NYD	JEV	KYB	KYB	JEV
QEX	NIJ	NIJ	QEX	XAN	FUV	FUV	XAN
JUF	PYM	PYM	JUF	FEP	NIQ	NIQ	FEP
XIB	FEP	FEP	XIB	VYR	LIJ	LIJ	VYR

B-A H m

17		18		19		20	
POD	WIG	WIG	POD	GAS	WED	WED	GAS
PAW	DAY	DAY	PAW	SON	RAM	RAM	SON
GEM	TOP	TOP	GEM	RIG	TOY	TOY	RIG
HIT	RED	RED	HIT	NOW	SIX	SIX	NOW
JAG	ROT	ROT	JAG	LAY	NUT	NUT	LAY
ROW	PAL	PAL	ROW	MUG	YES	YES	MUG

B-A L m

21		22		23		24	
SOJ	WUC	WUC	SOJ	ZYS	XAW	XAW	ZYS
ZAJ	YEV	YEV	ZAJ	YAF	WUX	WUX	YAF
QUV	LYW	LYW	QUV	TAS	QEH	QEH	TAS
XEK	HIW	HIW	XEK	XUQ	JIC	JIC	XUQ
VOH	CIJ	CIJ	VOH	GIC	VYX	VYX	GIC
KYZ	VAW	VAW	KYZ	CEQ	ZIY	ZIY	CEQ

C-A H m

25		26		27		28	
POD	WAR	WIG	TEN	GAS	FIB	WED	DOT
PAW	ZIP	DAY	MUG	SON	CUP	RAM	NOD
GEM	YET	TOP	YET	RIG	NOD	TOY	FIB
HIT	TEN	RED	ZIP	NOW	HAS	SIX	CUP
JAG	LAY	ROT	WED	LAY	GEM	NUT	GEM
ROW	MUG	PAL	COD	MUG	VAN	YES	VAN

C-A L m

29		30		31		32	
SOJ	DEJ	WUC	DEJ	ZYS	VOH	XAW	VOH
ZAJ	KIF	YEV	KIF	YAH	GEJ	WUX	ZAJ
QUV	MYP	LYW	VOB	TAS	FUV	QEH	XAN
XEK	GIC	HIW	QOS	XUQ	KIF	JIC	GEJ
VOH	ZUQ	CIJ	MYP	GIC	JEV	VYX	KIF
KYZ	FWP	VAW	ZUQ	CEQ	YOX	ZIY	JEV

B-C H m

33		34		35		36	
TEN	WIG	WAR	POD	SIN	WED	LIP	GAS
MUG	DAY	ZIP	PAW	NOD	RAM	CUP	SON
YET	TOP	YET	GEM	HAS	FIB	NOD	RIG
ZIP	RED	TEN	HIT	CUP	SIX	HAS	NOW
HIT	ROT	LAY	JAG	GEM	NUT	GEM	LAY
COD	PAL	MUG	ROW	VAN	YES	VAN	MUG

B-C L m

37		38		39		40	
DEJ	WUC	DEJ	SOJ	VOH	XAW	VOH	ZYS
KIF	YEV	KIF	ZAJ	ZAJ	WUX	GEJ	YAF
VOB	LYW	MUP	QUV	XAN	QEH	FUV	TAS
QOS	HIW	GIL	XEK	GEJ	JIC	KIF	XUQ
MYP	CIJ	ZUQ	VOH	KIF	VYX	JEV	GIC
ZUQ	NAW	FEP	KYZ	JEV	ZIY	YOX	CEQ

APPENDIX E

MEAN AND STANDARD DEVIATION TABLES

Table 1

Means and Standard Deviations for Total First-List Errors

with a 3/6 Correct Criterion

m	DOL_1	Paradigm							
		B - A		C - A		B - C		C - D	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
HIGH	LOW	18.58	7.61	19.50	9.21	21.83	13.73	21.58	13.81
	INTERMEDIATE	18.42	12.45	21.08	13.38	20.25	16.02	25.66	29.45
	HIGH	26.56	21.31	23.08	15.15	21.33	15.04	31.16	31.71
LOW	LOW	68.08	35.13	71.50	27.54	68.58	35.83	61.50	25.62
	INTERMEDIATE	69.58	41.35	73.33	36.70	71.83	38.93	70.25	26.02
	HIGH	71.75	38.29	75.25	33.86	77.67	24.33	75.75	49.96

Table 2

Means and Standard Deviations for Total First-List

Errors with a 6/6 Correct Criterion

<u>m</u>	DOL_1	Paradigm							
		B - A		C - A		B - C		C - D	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
HIGH	LOW	-	-	-	-	-	-	-	-
	INTERMEDIATE	48.58	27.85	47.17	37.19	37.83	16.27	56.0	51.95
	HIGH	46.17	38.25	44.75	23.81	46.58	23.88	56.50	48.73
LOW	LOW	-	-	-	-	-	-	-	-
	INTERMEDIATE	150.67	64.85	149.41	44.76	150.33	67.59	148.67	42.77
	HIGH	136.08	45.27	131,42	45.43	119.67	23.83	140.67	61.04

Table 3

Means and Standard Deviations for Total First-List Errors

with a 6/6 + 50% Criterion

<u>m</u>	DOL_1	Paradigm							
		B - A		C - A		B - C		C - D	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
HIGH	LOW	-	-	-	-	-	-	-	-
	INTERMEDIATE	-	-	-	-	-	-	-	-
	HIGH	56.25	56.58	52.50	26.50	53.00	25.51	64.33	54.56
LOW	LOW	-	-	-	-	-	-	-	-
	INTERMEDIATE	-	-	-	-	-	-	-	-
	HIGH	153.66	49.99	147.75	53.13	136.33	23.39	163.0	63.06

Table 4

Means and Standard Deviations for First-List Trials

to a 3/6 Correct Criterion

<u>m</u>	DOL_1	Paradigm							
		B – A		C – A		B – C		C – D	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
HIGH	LOW	4.83	1.99	5.42	1.98	6.25	2.77	5.67	2.56
	INTERMEDIATE	5.00	2.35	5.58	2.63	5.25	2.77	6.58	5.72
	HIGH	7.42	6.05	6.08	2.98	5.50	2.93	7.67	6.20
LOW	LOW	14.83	6.75	15.50	5.16	15.73	6.90	13.25	4.92
	INTERMEDIATE	17.92	7.32	16.17	7.28	14.00	6.99	15.37	5.07
	HIGH	16.00	7.28	15.58	7.80	17.17	5.73	16.47	9.32

Table 5

Means and Standard Deviations for First-List Trials

to a 6/6 Correct Criterion

$\underline{m}$	DOL_1	Paradigm							
		B - A		C - A		B - C		C - D	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
HIGH	LOW	-	-	-	-	-	-	-	-
	INTERMEDIATE	16.92	8.31	16.33	11.84	14.42	4.31	20.25	11.23
	HIGH	16.83	11.17	16.33	6.12	17.50	7.37	17.58	12.01
LOW	LOW	-	-	-	-	-	-	-	-
	INTERMEDIATE	47.00	14.12	43.25	10.04	36.67	14.08	41.50	8.97
	HIGH	38.50	10.09	35.67	12.78	36.58	6.53	40.75	16.88

Table 6

Means and Standard Deviations for First-List Trials

to a 6/6 + 50% Criterion

m	DOL_1	Paradigm							
		B – A		C – A		B – C		C – D	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
HIGH	LOW	–	–	–	–	–	–	–	–
	INTERMEDIATE	–	–	–	–	–	–	–	–
	HIGH	25.67	16.81	24.75	9.29	26.67	11.10	26.58	18.10
LOW	LOW	–	–	–	–	–	–	–	–
	INTERMEDIATE	–	–	–	–	–	–	–	–
	HIGH	58.25	14.99	53.75	19.05	55.17	9.71	61.42	25.25

Table 7

Means and Standard Deviations for Second-List

Total Errors

m	DOL_1	Paradigm							
		B – A		C – A		B – C		C – D	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
HIGH	LOW	24.92	14.95	29.50	13.59	34.42	17.31	42.40	18.86
	INTERMEDIATE	15.17	7.22	42.42	18.77	33.16	17.89	27.0	12.75
	HIGH	11.41	5.31	41.17	20.47	40.17	18.26	28.67	13.73
LOW	LOW	112.00	53.26	139.50	44.64	140.08	61.99	172.58	58.13
	INTERMEDIATE	77.75	24.74	120.67	27.63	109.33	39.00	128.75	52.02
	HIGH	51.92	25.94	110.90	49.19	158.42	30.81	127.90	52.16

Table 8

Means and Standard Deviations for Second-List

Trials to Criterion

m	DOL_1	Paradigm							
		B - A		C - A		B - C		C - D	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
HIGH	LOW	9.50	5.28	10.50	3.86	10.42	4.15	13.75	6.95
	INTERMEDIATE	6.58	2.53	14.50	6.10	10.33	4.55	9.08	3.35
	HIGH	5.33	2.78	14.33	7.17	14.83	6.61	10.17	5.23
LOW	LOW	31.75	14.29	37.67	10.67	38.50	14.22	47.92	15.12
	INTERMEDIATE	26.00	9.31	35.92	8.19	31.58	7.41	37.83	13.50
	HIGH	17.83	7.19	32.33	10.99	44.75	8.31	37.83	13.47

Table 9

Means and Standard Deviations for Second-List

Percentage of Transfer

m	DOL_1	Paradigm							
		B - A		C - A		B - C		C - D	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
HIGH	LOW	31.98	27.89	21.37	18.40	15.60	24.18	-	-
	INTERMEDIATE	31.93	22.84	-16.98	19.57	-3.12	24.68	-	-
	HIGH	49.88	23.01	-11.92	23.90	-10.47	22.18	-	-
LOW	LOW	25.54	22.97	12.87	16.06	14.76	22.29	-	-
	INTERMEDIATE	26.56	15.57	4.50	12.04	10.64	15.49	-	-
	HIGH	45.38	21.98	11.57	22.17	-9.56	10.28	-	-

Table 10

Means and Standard Deviations for Trials to Criterion

During Second-List Response Learning

m	DOL_1	Paradigm							
		B - A		C - A		B - C		C - D	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
HIGH	LOW	3.81	2.02	4.13	.92	4.61	1.27	5.33	1.63
	INTERMEDIATE	2.59	.68	5.29	1.27	4.27	1.32	4.55	1.66
	HIGH	2.18	.65	5.74	2.04	5.18	1.86	4.66	1.50
LOW	LOW	11.31	4.95	14.26	3.38	16.01	5.99	15.33	4.83
	INTERMEDIATE	7.55	2.62	12.15	3.77	11.40	4.55	12.50	4.48
	HIGH	6.69	3.25	10.59	3.73	15.51	3.44	12.62	4.22

Table 11

Means and Standard Deviations for Second-List

Total Errors During Associative Learning

m	DOL_1	Paradigm							
		B - A		C - A		B - C		C - D	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
HIGH	LOW	7.00	6.78	10.25	9.49	11.00	12.52	15.91	12.54
	INTERMEDIATE	4.59	5.60	16.25	13.82	8.33	6.89	6.83	8.63
	HIGH	2.92	5.07	12.50	11.47	15.50	11.28	6.41	6.46
LOW	LOW	48.66	29.14	58.75	29.07	47.25	27.46	86.00	47.94
	INTERMEDIATE	39.17	24.36	53.08	15.25	48.08	29.13	62.00	32.84
	HIGH	16.37	12.00	51.91	32.76	73.08	35.59	60.00	46.15

Table 12

Means and Standard Deviations for Percentage of Transfer

During Second-List Response Learning

$\underline{m}$	DOL_1	Paradigm							
		B - A		C - A		B - C		C - D	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
HIGH	LOW	21.34	21.68	13.79	11.00	8.96	13.61	-	-
	INTERMEDIATE	28.39	11.60	-6.05	11.59	5.30	14.01	-	-
	HIGH	37.41	15.94	-7.26	16.57	-1.70	16.68	-	-
LOW	LOW	19.26	22.47	4.97	12.06	1.28	18.45	-	-
	INTERMEDIATE	26.90	17.20	4.14	18.17	8.44	19.21	-	-
	HIGH	32.57	22.25	11.32	16.39	-8.42	15.47	-	-

Table 13

Means and Standard Deviations for Percentage of Transfer

During Second-List Associative Learning

$\underline{m}$	DOL_1	Paradigm							
		B - A		C - A		B - C		C - D	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
HIGH	LOW	49.40	37.16	32.85	32.36	37.48	45.36	-	-
	INTERMEDIATE	44.99	53.55	-15.39	46.18	9.04	44.39	-	-
	HIGH	57.71	41.49	-12.99	39.24	-21.94	42.19	-	-
LOW	LOW	33.19	26.03	23.26	22.71	34.45	26.49	-	-
	INTERMEDIATE	28.05	23.78	9.61	14.21	19.19	25.66	-	-
	HIGH	60.92	23.87	16.77	33.76	-3.25	26.20	-	-

Table 14

Means and Standard Deviations for Intralist

Intrusions During Second-List Acquisition

m	DOL_1	Paradigm							
		B - A		C - A		B - C		C - D	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
HIGH	LOW	3.58	3.20	5.33	5.37	4.83	6.13	5.08	3.12
	INTERMEDIATE	2.25	2.58	6.50	7.17	2.67	2.14	2.75	2.27
	HIGH	.83	.89	6.92	4.63	6.58	5.33	3.83	5.29
LOW	LOW	8.58	8.48	10.66	7.26	7.92	6.39	15.66	9.99
	INTERMEDIATE	8.58	6.02	14.25	8.68	7.58	135.69	11.58	8.20
	HIGH	3.17	4.06	18.33	11.28	13.58	7.31	11.50	5.85

Table 15

Means and Standard Deviations for Percentage of Intralist Intrusions During Second-List Acquisitions

$\underline{m}$	DOL_1	Paradigm							
		B - A		C - A		B - C		C - D	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
HIGH	LOW	8.17	7.12	11.62	8.70	10.20	9.57	11.04	8.36
	INTERMEDIATE	6.69	6.19	11.64	11.42	7.39	5.23	9.18	7.88
	HIGH	3.20	3.35	14.25	10.84	9.84	6.21	6.31	7.37
LOW	LOW	8.14	5.22	9.78	6.00	7.81	5.84	9.82	4.46
	INTERMEDIATE	8.74	4.57	12.64	7.81	7.04	3.62	10.15	5.51
	HIGH	4.12	4.47	14.47	7.40	9.85	4.30	9.45	4.64

APPENDIX F

ANALYSIS OF VARIANCE SUMMARY TABLES

Table 1

Summary of the Analysis of Variance for

First-List Total Errors with a

3/6 Correct Criterion

Source	df	MS	F
m (A)	1	171618.000	294.696*
DOL_1 (B)	2	1011.826	1.746
Paradigm (C)	3	63.486	.109
A x B	2	58.854	.101
A x C	3	312.546	.536
B x C	6	97.215	.167
A x B x C	6	60.039	.103
Error	264	582.626	-

* $p < .0001$

Table 2

Summary of the Analysis of Variance for

First-List Total Errors with a

6/6 Correct Criterion

Source	df	MS	F
m (A)	1	414408.331	195.360*
DOL_1 (B)	1	3350.024	1.579
Paradigm (C)	3	1163.457	.548
A x B	1	4294.086	2.024
A x C	3	128.600	.061
B x C	3	125.760	.059
A x B x C	3	585.423	.276
Error	176	2121.251	-

* $p < .0001$

Table 3

Summary of the Analysis of Variance for

First-List Total Errors with a

6/6 + 50% Criterion

Source	df	MS	F
m (A)	1	210562.67	88.856*
DOL_1 (B)	-	-	-
Paradigm (C)	3	1558.57	.658
A x B	-	-	-
A x C	3	296.69	.125
B x C	-	-	-
A x B x C	-	-	-
Error	88	2369.69	-

* $p < .0001$

Table 4

Summary of the Analysis of Variance for

First-List Trials to Criterion

(3/6 Correct)

Source	df	MS	F
m (A)	1	6757.00	204.570*
DOL_1 (B)	2	43.51	1.317
Paradigm (C)	3	2.21	.076
A x B	2	6.86	.207
A x C	3	15.46	.468
B x C	6	13.76	.416
A x B x C	6	14.07	.425
Error	264	33.03	-

* $p < .0001$

Table 5

Summary of the Analysis of Variance for

First-List Trials to Criterion

(6/6 Correct)

Source	df	MS	F
m (A)	1	25323.05	197.020*
DOL_1 (B)	1	206.26	1.600
Paradigm (C)	3	148.43	1.155
A x B	1	223.16	1.736
A x C	3	57.39	.446
B x C	3	83.10	.646
A x B x C	3	67.66	.526
Error	176	128.53	-

* $p < .0001$

Table 6

Summary of the Analysis of Variance for

Second-List Total Errors

Source	df	MS	F
m (A)	1	583053.476	469.118***
DOL_1 (B)	2	9083.125	7.308**
Paradigm (C)	3	23962.105	19.279**
A x B	2	5881.819	4.732*
A x C	3	7281.328	5.858**
B x C	6	3752.616	3.019*
A x B x C	6	1548.560	1.246
Error	264	1242.872	-

*** $p < .0001$
** $p < .001$
* $p < .01$

Table 7

Summary of the Analysis of Variance for

Second-List Trials to Criterion

Source	df	MS	F
m (A)	1	42229.337	494.701****
DOL_1 (B)	2	333.635	3.908*
Paradigm (C)	3	1487.457	5.710***
A x B	2	249.441	2.922
A x C	3	495.735	5.807***
B x C	6	352.978	4.135**
A x B x C	6	76.061	.891
Error	264	85.363	-

**** $p < .0001$
*** $p < .001$
** $p < .01$
* $p < .025$

Table 8

Summary of the Analysis of Variance for

Second-List Percentage of Transfer

Source	df	MS	F
m (A)	1	797.227	1.686
DOL_1 (B)	2	2469.356	5.223**
Paradigm (C)	2	24547.491	51.926****
A x B	2	1162.834	2.459
A x C	2	1499.317	3.171*
B x C	4	3862.689	8.171***
A x B x C	4	571.796	1.209
Error	198	472.851	-

**** $p < .0001$
*** $p < .001$
** $p < .01$
* $p < .05$

Table 9

Analysis of Variance for Percentage of Transfer During Second-List Response Learning

Source	df	MS	F
_m_ (A)	1	.04	.000
DOL_1 (B)	2	16.03	.053
Paradigm (C)	2	14741.92	48.169**
A x B	2	534.57	1.740
A x C	2	596.69	1.949
B x C	4	1480.39	4.837*
A x B x C	4	442.48	1.445
Error	198	306.04	-

** $p < .0001$
* $p < .01$

Table 10

Analysis of Variance for Percentage of Transfer During Second-List Associative Learning

Source	df	MS	F
m (A)	1	1146.83	.852
DOL_1 (B)	2	8742.04	6.497**
Paradigm (C)	2	29594.18	21.995***
A x B	2	3302.45	2.450
A x C	2	3051.94	2.260
B x C	4	7857.28	5.830*
A x B x C	4	497.03	.363
Error	198	1345.51	-

*** $p < .001$
** $p < .005$
* $p < .01$

Table 11

Analysis of Variance for

Intralist Intrusions

Source	df	MS	F
m (A)	1	3220.00	75.268***
DOL_1 (B)	2	28.36	.663
Paradigm (C)	3	429.35	10.036**
A x B	2	8.63	.202
A x C	3	90.34	.112
B x C	6	148.76	3.478*
A x B x C	6	36.17	.845
Error	264	42.78	-

*** $p < .0001$
** $p < .001$
* $p < .005$

Table 12

Analysis of Variance for Mean

Percentage of Intralist Intrusions

Source	df	MS	F
_m_ (A)	1	4.62	.085
DOL_1 (B)	2	8.15	.150
Paradigm (C)	3	437.85	8.080*
A x B	2	47.79	.880
A x C	3	14.99	.270
B x C	6	105.95	1.960
A x B x C	6	4.11	.075
Error	264	51.52	-

* $p < .001$