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TRANSFER OF INCIDENTALLY LEARNED ASSOCIATIONS IN "R-S" PARADIGMS. A TEST OF FREQUENCY AND ASSOCIATIVE HYPOTHESIS OF VERBAL DISCRIMINATION LEARNING

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A TEST OF FREQUENCY AND ASSOCIATIVE HYPOTHESIS OF
VERBAL DISCRIMINATION LEARNING

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TRANSFER OF INCIDENTALLY LEARNED ASSOCIATIONS IN "R-S" PARADIGMS. A TEST OF FREQUENCY AND ASSOCIATIVE HYPOTHESIS OF VERBAL DISCRIMINATION LEARNING

INTRODUCTION

The present paper investigates the backward transfer paradigm in verbal discrimination (VD) learning. Backward transfer paradigm was defined by Houston (1964) in paired associate task. In paired associate task the backward paradigms inolve the similarity of the relationship 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). Likewise, in VD task the backward paradigm involves the similarity relationship between first list wrong items and second list right items (W_1-R_2) and between second list wrong items and first list right items (W_2-R_1). The four basic backward paradigm generated from paired associate task to VD task are (1) W_1-R_1, ${}^{W}R_1$-${}^{R}W_1$ (analogous to A-B, B-A paradigm in paired associate learning; (2) W_1-R_1, W_2-${}^{R}W_1$ (analogous to A-B, C-A paradigm); (3) W_1-R_1, ${}^{W}R_1$-R_2 (analogous to A-B, B-C paradigm); and (4) W_1-R_1, W_2-R_2 (analogous to A-B, C-D control paradigm). The present investigation was an extension of Kanak and Dean's (1969) study on forward paradigm into backward paradigm for testing frequency mechanism, incidental associative processes and high order processes.

The major reason for the recent interest in investigation of verbal discrimination learning is due to the frequency theory of VD learning (Ekstrand, Wallace and Underwood, 1966). According to the frequency theory the subjective frequency differential between R and W items in a VD pair provides the basis for discrimination. Four responses are assumed by Ekstrand _et al_. (1966) to be sources of frequency units. First the representational response (RR) is assumed to add frequency as a function of the subject's perception of the verbal units to be discriminated. Thus, the RR would add a frequency unit to both R and W items yielding a 1:1 frequency ratio for each pair. Second, it is assumed that the pronunciation (PR) of the response adds another unit of frequency to the item selected. If the PR response is given to the R item of a pair, there will be 2:1 frequency ratio, favoring the R item. The third, the rehearsal of the correct response (RCR), is assumed to add frequency to the R item via the overt or covert PR during the feedback interval. Thus, a frequency difference of 3:1 favoring the right member should result. An implicit associative response (IAR, Bousfield, Whirmarsh, and Danick, 1958) is assumed to add frequency in a fourth way. When word associates are present in a list, the perception of one member of the word associate pair is assumed to elicit its associate. Thus the presentation of the word "Table" in a list would add a frequency unit to its primary associate, "chair" via the IAR. The effect of IARs on the differential frequency cue is a complex function of the manner in which the associates are manipulated in the list.

Ekstrand _et al_. (1966) applied frequency theory to interpret earlier studies of VD transfer effects. If 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 they have defined two rules. If the transfer list involves old R items from list 1 but new W items in list 2 (W_1-R_1, W_2-R_1) performance is optimized using Rule 1 strategy (Rule 1 = select the most frequent items). If the transfer list involves new R items in the list 2 but old W items from list 1 (W_1-R_1, W_1-R_2) performance is optimized via the use of Rule 2 (Rule 2 = select less frequent items). The rule 2 leads to interesting predictions regarding transfer performance. On early list 2 trials S can adopt the rule to choose the item with the lowest subjective frequency in each pair. However, the subjective frequency of a R items increases faster over trials than that of W items and a point will be reached at which the subjective frequencies are approximately equal for R and W, making the discrimination more difficult. At this point, S cannot effectively utilize a rule and he is expected to eventually change his rule and select the most frequent item. Thus, adoption of a rule 2 mode of responding would lead to positive transfer on early trials, when compared to nonspecific control group, reaching chance level as trials progress and eventually result in negative transfer in later trials.

It should be noted that according to frequency theory the list is mastered when the "rule" condition (Rule 1 or Rule 2) have been established for all pairs. In other words, "rule 1" or "rule 2" do not necessarily mean that subjects consciously apply the rule as a general listwide principle, or higher-order process, but rather PR_S and RCR_S would lead to the condition of R item frequency being greater than W item frequency for every pair in the list. Consequently, at some point in practice every pair reaches that level where Rule 1 offers a reliable means of selecting the R items.

Historically, frequency theory had its beginning in a transfer study by McClelland (1942). After his Ss had partially learned a list, for half of the pairs new wrong words and for the other half new R words were substituted. His results showed that when new W words were introduced with old right words (W_2-R_1 paradigm) the S showed no decrement in performance. However, when new R words were introduced with old wrong words (W_1-R_2 paradigm) the subject showed a significant decrement in performance.

Underwood, Jesse and Ekstrand (1964) replicated this study with three changes being made in the procedures. Underwood et. al. (1964) used a between subject design, rather than a mixed-list procedure, a list was learned to a criterion of three successive perfect trials, and Ss were fully informed about the relationship between the first and second list. The design was 2 x 3 factorial with the length of the anticipation interval on the second list (1.5 : 2 sec or 3 : 2 sec) manipulated as one variable and paradigm as the other variable.

The three paradigmatic variations were as follows. The W and R items of list 1 (W_1-R_1) were replaced by completely new items in list 2 (W_2-R_2)--thus making this a control paradigm (W_1-R_1, W_2-R_2) for nonspecific transfer effects. The W items were identical on both lists but the R items of list 1 were replaced by new R items on list 2 (W_1-R_1, W_1-R_2 paradigm), and the R items were identical on both lists but the W items of list 1 were replaced by new W items on list 2 (W_1-R_1, W_2-R_1). The result showed nearly perfect positive transfer for W_2-R_1 paradigm compared to the control group. For the W_1-R_2 paradigm performance on the seocnd list was initially very high, but performance became inferior to the contorl on later trials. These results correspond well with the predictions of a frequency-based theory.

Support for the frequency theory has been found in a study by Raskin, Boice, Rubel, and Clark (1968), who used two "backward" paradigms. In one paradigm, W and R items were reversed on the second list (W_1-R_1, ${}^{W}R_1$-${}^{R}W_1$) while in another paradigm the W item of the second list were new items but R items of the second list were W items on the first list (W_1-R_1, W_2-${}^{R}W_1$). According to frequency theory in the ${}^{W}R_1$-${}^{R}W_1$ paradigm S will apply rule 2. Since second list W items have more frequency accrued from functioning as first list R items while second list R items will have relatively less frequency, there should be positive transfer on early trials followed by decrement in performance on later trials as compared to W_2-R_2 control group. For the W_2-${}^{R}W_1$ paradigm S should use rule 1 since second list R items have already some frequency units added as a result of functioning as first list W items. Thus a decrement in performance in later trials would not be expected in this paradigm. They obtained the result as was predicted by the frequency theory. Raskin et al. (1968) also facotrially varied instructions in their design and found that in both experimental paradigms the instructed group made significantly fewer errors than their non-instructed groups.

King and Levin (1971) test the frequency theory in VD transfer by varying list 1 trials in two different paradigms, W_1-R_1, W_1-R_2 and W_1-R_1, ${}^{W}R_1$-R_2. List one trials were varied at 2, 4 or 8 trials. According to frequency theory both groups W_1-R_2 and ${}^{W}R_1$-R_2 should use Rule 2. Therefore, they should do better than a W_2-R_2 control group on early list 2 trials compared to the control group, but poorer on later trials when discrimination based on frequency breaks down. The crossover effect should vary as a function of the number of list 1 trials, i.e., as degree of list one increases, the relative frequency for R and W items will be equalized later in list 2 trials than when degree of list one learning is less. Since a greater frequency build-up occurs for R items than for list 1 W items, the effect of varying list 1 trials should be more pronounced for the $^{W}R_1$-R_2 paradigm than for the W_1-R_2 paradigm. Transfer performance was consistent with the predictions of frequency theory.

Wallace, Remington and Beito (1972) supported frequency theory by using the study-test method with two paradigms, W_1-R_1, W_1-R_2 and W_1-R_2, W_2-R_1 in a measure of overall performance but an analysis of performance across trials was not reported. The control group was a normal forgetting control group instead of nonspecific transfer control group since the primary interest was in retention rather than transfer phenomena.

In an extension of the Underwood <u>et</u>. <u>al</u>. (1964) study, Kausler and Dean (1967), using a mixed list, obtained positive transfer in the W_1-R_1, W_2-R_1 paradigm, but found negative transfer throughout the second list in W_1-R_2 paradigm. Furthermore, they used two mediated transfer paradigms, W_1-R_1, W_2-R'_1 and W_1-R_1, W'_1-R_2. In the W_2-R'_1 paradigm the R items in the second list were associated (54% or greater) to the first list R items, while in the W'_1-R_2 paradigm the W items in second list were associated (54% or greater) to the first list W items. The results showed that mediated positive and negative transfer were demonstrated in W_2-R'_1 and W'_1-R_2 paradigms, respectively, Kausler, Fulkerson and Eschenbenner (1967) used a between S- design, obtaining further evidence for lack of positive transfer in the early trials in the W_1-R_2 paradigm.

Thus interpretations based on a mechanism of direct frequency units seems inadequate to explain the findings of Kausler and his associates and additional mechanisms to account for negative transfer in the W_1-R_2 paradigm seems necessary. Kausler (1966) proposed a conceptualization referred to as a multiple component analysis to explain these findings.

Kausler (1966) conceptualized learning as involving both intentional and incidental components. The direction and degree of VD transfer becomes the resultant of interacting intentional and incidental learning processes operating during list 2 practice. In the standard VD task the intentional component requires S to recognize the R items within the context of the W-R pairing and verbalize these items overtly in their own presence. An additional intentional component consists of recognition of W items and avoiding its verbalization. This process is closely akin to frequency mechanism postulated by Underwood (1964). The incidental component consists of the acquisition of bidirectional associations between W and R items as a result of rote contiguity learning. The occurrence of negative transfer for list 2 performance implies a potential dependence between incidentally acquired W-R associative processes and intentionally acquired recognition processes. In other words, incidental associations build-up between R and W items in the VD task. These incidental associations are subject to interference like intentionally learned associations. That is, the W_1-R_1 and W_1-R_2 associations enter into the competition, unlearning (A-B, A-C) relationships characteristic of paired associate transfer. Support for the competition unlearning hypothesis was obtained by Kausler et. al. (1967) and Eschenbrenner and Kausler (1968) in W_1-R_1, W_1-R_2 paradigm by showing that retroactive inhibition of retention of List 1 W-R associations was correlated with second list performance for the W_1-R_2 paradigm.

Kanak and Dean (1969) reported two experiments systematically investigating VD transfer effects under interacting conditions of frequency rule application and incidental associative interference in order to determine that both types of mechanisms are involved in VD transfer. The major purpose of experiment one was to establish primary transfer laws which might result in a transfer surface for VD task. For VD transfer surface 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 degree of similarity between R_1 and R_2. The surface predicts that when W items and R items are identical, maximal positive transfer will be obtained. As the similarity between first and second list R items decreases, positive transfer will decrease, followed by increasing negative transfer when second list R items are neutral with respect to the first list R items (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 a decreasing amount of negative transfer (W_1-R_2 varied to W_2-R_2). Kanak and Dean's results indicate that with R item identity and W item similarity varied, transfer is highly positive. The W_1-R_1, W'_1-R_1 and W_2-R_1 conditions yielded superior performance over all the other paradigms, but none of the three differed significantly from each other. This suggests that in those paradigms where Rule 1 is applicable, an incidentally learned associative interference component is absent or only minimally of influence. The W_1-R_2 condition, however, was significantly inferior to the W_2-R_2, W_1-R'_1 and W_1-R_1as well as the W_2-R'_1 condition. Thus, effects of associative interference were strongly supported in those paradigms where Rule 2 rahter than Rule 1 was appropriate. The W_2-R'_1 condition was significantly superior to the W'_1-R_2 condition, indicating relatively greater effectiveness of mediated R-item transfer over mediated W-item transfer. Kanak and Dean concluded that frequency cues generally determine the direction of transfer while associative mechanisms account for the degree of transfer.

Experiment II extended the analysis of VD transfer effects in which re-pairing of list 1 W and R item occurs in list 2. Further support to the notion of incidentally learned associative interference was provided by comparing corresponding (C) and non-corresponding (NC) pairing transfer conditions. The NC condition is defined in terms of re-pairing of first list W and R items. The C and NC paradigms employed were W_1-R_1, W'_1-R_1, and W_1-R'_1. A nonspecific transfer control group, W_2-R_2 was also employed. In comparisons of C and NC paradigms frequency theory would predict the null hypothesis since the role of frequency mechanisms is equal in both lists. An associative account, on the other hand, would predict interference from competing W-R and R-W association under NC conditions, with resultant negative transfer relative to C paradigms. The results clearly supported the role of associative mechanisms. The number of errors was significantly greater for NC conditions than for C conditions.

Wallace and Nappe (1971) and Wallace (1972) proposed that the decrement obtained by Kanak and Dean in the NC paradigms could be accounted for within frequency theory by liberalizing the counting postulates without the necessity of invoking the operation of associative processes. The basic postulate of the Ekstrand _et_. _al_. (1966) theory was that each trial adds at lease two frequency units to R items and one unit to W items. Wallace and Nappe suggest that there may be variability in the accural frequency units within the set of R items and within the set of W items as a function of differences in item saliency, favorable or unfavorable study positions, a changing environmental background against which items are presented, and certain organismic factors such as attentional set. They argued that Kanak and Dean's procedure of re-pairing items in the transfer task may have allowed some more frequent W items to become paired with less frequent R items and vice versa. Wallace and Nappe attempted to provide empirical support for this hypothesis by systematically re-pairing R items with W items possessing greater frequency and did demonstrate the performance decrement on a subsequent single test trial. The magnitude of the re-pairing decrement, however, was not great (a 27% increase in errors for C to NC, while Kanak and Dean reported a 174% increase in errors on transfer list). Wallace (1972) also reported a small decrement in the NC paradigm but comparative interpretation of his data is limited due to methodological differences in his study. He used differential rates of presentation in phase 1 and phase 3 and he used an interpolated phase 2 involving frequency judgment tasks.

Kanak and Knight (1974) attempted to minimize the possibility of more frequent W items becoming paired with less frequent R items in list 2 of the W_1-R_1 (NC) paradigm This was accomplished by increasing the situational frequency of the R items via a prior familiarization task involving free recall training. Two additional C and NC conditions were given an identical degree of free-recall training on an irrelevant list of words not utilized in the VD task to confirm the facilitative effect of relevant familiarization upon list 1 learning and to represent a condition closer to that originally utilized by Kanak and Dean. The results supported Kanak and Dean's original finding. A significant decrement in performance was obtained for both R-item familizarization and irrelevant familiarization. This provides strong evidence that even the advantage is given to frequency mechanisms by prior R-item familiarization, associative mechanisms still represent a significant source of negative transfer.

Paul (1972) raised the problem concerning the use of the term "rule" by frequency theorists. According to Paul, an intrapair discrimination need not be made by the frequency attribute alone. Paul's analysis of VD learning implies that frequency theory use of the term rule has an underlying connotation of a "pair-specific" process. In other words, frequency units occur through a response of PR, RCR, or IAR to an item which eventually leads to the condition where there is more subjective frequency build-up for R items as compared to W items. The list is mastered when greater frequency units of R members than W items have been established for all pairs. Thus, the term"Rule" as used by frequency theorists is misleading since a rule effect generally refers to a listwide or higher-order process.

Paul's evidence for a listwide process came from a number of studies carried out by him and his associated involving the percentage of items reversed in function on a transfer task. Paul (1966, 1968) discovered that after first list overlearning a 100% reversal condition yielded virtually errorless performance. He further noted that for a 75% reversal condition, a greater percentage of errors occurred on the three unchanged items than on the nine reversed items, i.e., subjects in 75% reversal conditions responded as if a 100% reversal shift were in effect. This supports the involvement of a listwide process or some rule indicating "do the opposite of what you have been doing" (Kausler, 1973). When the reversal involved 50% or 25% of the items there were more errors for the shifted pairs. Here the shift could be mediated only at the pair-specific level. Similar results were obtained when the degree of learning was reduced to a criterion of one errorless trials. However, the effects were less potent than those observed with overlearning group.

Paul and Callahan (1972) advanced a "Differentiation-Suppression Hypothesis" suggesting that correct responses of task one form a functional concept "task 1 correct response." During task two learning, the nonreinforcement of task one responses, in effect, activates the implicit self-instruction, "suppress the old correct response." This self-instruction generalized to listwide rather than functioning pairwise. The overlearning in task one increases the discriminability to shift from task one to task two condition and thus facilitates the performance in task two.

Further support for Paul's interpretation of a rule effect was illustrated in a study by Kausler and Farazanegan (1969). Performance was significantly facilitated when all R items were homogeneous with respect to all low meaningfulness and W items with respect to all high meaningfulness as compared to control conditions containing R and W items that were heterogenous with respect to meaningfulness. Hence, the verbal discrimination task offers great potential for investigating listwide or higher-order processes. It should be noted that Paul's interpretation does not deny frequency as a basis for intrapair discrimination, but insists that additional assumptions are necessary to explain transfer performance in some situations.

Kanak and Dean (1969) concluded that in VD transfer effect both frequency rule and incidental associative interference mechanisms are involved in VD transfer. The purpose of experiment one of the present study was to demonstrate that in addition to frequency mechanisms, incidental associative processes and high-order processes (Paul, 1972) are involved in "backward" paradigms of VD transfer. Three backward transfer paradigms and the usual nonspecific control group were employed in the present study. The three transfer paradigms were W_1-R_1, ${}^{W}R_1$-${}^{R}W_1$; W_1-R_1, W_2-${}^{R}W_1$; and W_1-R_1, ${}^{W}R_1$-R_2, while the control group was W_1-R_1, W_2-R_2.

The following predictions are made according to frequency theory. In the W_1-R_1, ${}^{W}R_1$-${}^{R}W_1$ or reversal paradigm, the same pairs are presented on both lists with only the designation of R and W items reversed on the second list. Here Ss should employ rule 2 responding since the W items of list 2 are R items of list one in this paradigm and, therefore, Ss should select the items which are less frequent. The frequency theory thus predicts that there should be positive transfer, compared to the control group, on the early trials, but as learning progresses R items of the second list will build frequency at a faster level than W items with a resultant deterioration of the effectiveness of a Rule 2 cue and a decline in performance. On later trials Ss would switch to rule 1 and respond to more frequent items in order to be correct. At this point there would be negative transfer when compared to the control group which presumably utilizes Rule 1 responding throughout List 2 practice.

In W_1-R_1, W_2-${}^{R}W_1$ paradigm R items in the list 2 are the W items of list 1. The R items of the second list, therefore, have an initial frequency advantage over the new W item as a reuslt of their having served as W items of the first list. Ss in this paradigm should use a Rule 1 strategy. The theory predicts initial and continuing positive transfer relative to the control.

In the W_1-R_1, ${}^{W}R_1$-R_2 paradigm, the R items of the first list are now W items in list 2 while R items are new in the second list. The Ss, therefore, should use a Rule 2 strategy of selecting the less frequent items.

Accordingly, in this paradigm, as in the reversal paradigm, early positive transfer should be followed by an increase in errors and a decrement in performance in later trials relative to the control group.

It should be noted that the ${}^{W}R_1$-${}^{R}W_1$ and ${}^{W}R_1$-R_2 paradigms both provide the opportunity rule 2 strategy. However, the frequency differences between R and W items at the beginning of second list practice are not equal in the two paradigms. In ${}^{W}R_1$-${}^{R}W_1$ paradigm W items in the second list will have more frequency build up from first list R item learning while the R items of list 2 will have some frequency build up from first list W items. Therefore, there will be, for example, a 3:1 ratio between W and R items respectively in the second list. In the ${}^{W}R_1$-R_2 paradigm, like the ${}^{W}R_1$-${}^{R}W_1$ paradigm, W items in the second list will have more frequency already built up from first list R item learning, but in this paradigm second list R items are new. Therefore, there will be, for example, a 3:0 ratio existing between W and R items respectively in the second list.

It should, therefore, take more trials to build equal frequency between R and W items in the ${}^{W}R_1$-R_2 paradigms as compared to ${}^{W}R_1$-${}^{R}W_1$ where closer frequency between R and W items exists at the beginning of second list learning. In other words, positive transfer should decrease more slowly in the ${}^{W}R_1$-R_2 paradigm as compared to the ${}^{W}R_1$-${}^{R}W_1$ paradigm.

The incidental associative interference hypothesis, on the other hand, makes different predictions for these three paradigms. The application of incidental associative mechanisms to VD transfer implies the learning of contiguous intrapair associations (i.e., W-R and R-W associations during practice on VD task). Sardello and Kausler's (1967) study has shown that R→W directional associations are generally weaker than W→R associations when measured by modified-free recall. This is consistent with frequency theory since R items should accrue greater availability for recall than W items. Therefore, in verbal discrimination transfer, R-W incidental associations should produce less interference than W-R incidental associations.

In the W_1-R_1, ${}^{W}R_1$-${}^{R}W_1$ paradigm a weaker R-W incidental association facilitates performance since W item of list 2, which was originally the R item of list one, would elicit the W item of list one by backward incidental learning, which is not the R item in list two. On the other hand, W-R incidental learning produces interference since the R item of list 2 was originally the W item of list one. W items elicit R items of list one which become W items in list 2. Thus in this paradigm R→W associations facilitate while W→R associations should have an interfering effect. This paradigm leads to an interesting test of associative theory.

In the W_1-R_1, W_2-${}^{R}W_1$ paradigm the weaker R-W incidental association is not activated since the list 1 R item is not involved in list 2. The stronger W-R association, however, should have an interfering effect because the wrong item of list one (which is R item in list 2) elicits the first list R item. This leads to competition between second list R items and first list R items. According to an associative interpretation, one would therefore expect negative transfer in the Rule 1 type paradigm, which is contrary to frequency theory predictions.

In the ${}^{W}R_1$-R_2 paradigm the W-R incidental association is not activated since the W item of list one is not involved in list two. The R→W incidental associations, however, should have an interfering effect via list 2 W items which was originally learned by <u>Ss</u> as R items. This list one R item elicits the W item of list W_1. This leads to competition between list one wrong item and list two R item. For this paradigm R-W associations of lists 1 and 2 enter into an A-B, A-C relationship. Since R→W recall is generally weaker than W→R, associative interference predicts weaker negative tranference in this paradigm than in the $W_2\text{-}{}^{R}W_1$ paradigm. However, the potency of W→R interference in the $W_2\text{-}{}^{R}W_1$ paradigm may be substantially mitigated by Rule 1 cues, as shown by the fact that the re-pairing paradigm of Kanak and Dean (1969) and Kanak and Knight (1974) still yielded positive transfer relative to the nonspecific control.

According to Paul's interpretation, Ss should respond according to listwide rule effects instead of frequency differences per se. According to a Differentiation-Suppression hypothesis $W_1\text{-}R_1$, ${}^{W}R_1\text{-}{}^{R}W_1$ and $W_1\text{-}R_1$, ${}^{W}R_1\text{-}R_2$ should use the implicit self-instruction "suppress the old correct response" during task two. However, differentiation would be greater for $W_1\text{-}R_1$, ${}^{W}R_1\text{-}R_2$ paradigm due to first R items becoming W items.

A close comparison of experiments supporting frequency theory with those supporting an associative interference theory reveals one major factor that my be contributing to the differential results. All studies supporting frequency theory (except King and Levin, 1972) fully informed their Ss at the start of list 2 practice about the nature of the relationship between the two lists while studies supporting associative interference have never given any specific instructions about the existing relationship between the two lists. This implies that instructions regarding the interlist relationship may be important in determining the degree of influence of incidentally learned associations. Underwood, Jesse and Ekstrand (1964) informed their Ss about the interlist relationship and positive transfer was reported in the $W_1\text{-}R_1$, $W_1\text{-}R_2$ paradigm (analogous to the A-B, A-C paradigm in paired associate transfer), while Kanak and Dean (1966) and Kausler and Dean (1969) obtained negative transfer when Ss were not informed about relationships between the two lists. Wallace and Nappe (1971) also informed their Ss of the re-pairing manipulation and obtained less decrement in performance compared to Kanak and Dean (1969) and Kanak and Knight (1974), who had not informed their Ss about any specific relationship between the two lists. Raskin, Boice, Rubel, and Clark (1968) factorially varied instructions and found performance of the instruction group was facilitated compared to non-instructed groups in W_1-R_1, ${}^{W}R_1$-${}^{R}W_1$ and W_1-R_1, W_2-${}^{R}W_1$ paradigm. The present study, therefore, also manipulates instructions as an additional variable.

Experiment I

Method

Subjects. The Ss were 96 undergraduate students enrolled in introductory psychology classes at the University of Oklahoma. The students participated in the experiment as an option among class requirements and all Ss were naive with respect to prior participation in verbal learning experiments. Twelve Ss were assigned by a randomized block procedure to each of eight experimental conditions in the order of their appearance at the laboratory.

Design. The design was a 4 x 2 factorial with 4 paradigms as one variable and instruction vs. noninstruction as another variable making 8 independent groups. The four transfer paradigms were (1) W_1-R_1, ${}^{W}R_1$-${}^{R}W_1$ (analogous to the A-B, B-A paradigm in paired associate learning); (2) W_1-R_1, W_2-${}^{R}W_1$ (analogous to the A-B, C-A paradigm); (3) W_1-R_1, ${}^{W}R_1$-R_2 (analogous to the A-B, B-C paradigm); and (4) W_1-R_1, W_2-R_2 (analogous to the A-B, C-D paradigm).

List. Forty-eight words were selected from the Paivio, Yuille and Madigan (1968) norms. All words had a frequency count of A or AA on the Thorndike and Lorge (1944) G_1 scale. The words were equated on meaningfulness (M = 5.77) and on imagery (M = 4.37) on the basis of the same norms and all words were associatively unrelated. This was determined from normative sources (e.g., Palermo and Jenkins, 1964; Shapiro and Palermo, 1968). The Ss in each of the eight conditions were presented two VD lists each containing 12 pairs. Two different pairings (set A and B) were prepared for the purpose of greater control and greater generalization and within each set item function was counterbalanced.

From a pool of 48 unrelated words, 24 words were randomly selected and were randomly paired as the 12 W_1-R_1 pairs of list for Set A. Twelve additional words were randomly selected from the pool to serve as the R_2 items of List 2 for the ${}^{W}R_1$-R_2 and W_2-R_2 paradigms. The remaining 12 words served as W_2 items of list 2 for the W_2-${}^{R}W_1$ and W_2-R_2 paradigms. A difference pairing of W and R items of Set A was used to prepare the lists for Set B. Two more lists were constructed by reversing the W and R item function in each set with randomization of W-R pairing throughout. The 12 Ss in each group were alternately assigned to A_1, A_2, B_1, B_2 subgroups (n = 3). All 4 sets were equally counterbalanced for List 1 and List 2 learning. Care was taken that each list was constructed of constant proportion of pairs of nouns and adjectives in each paradigm. In addition, lists were constructed to minimize interlist or intralist associative relationships. All transfer groups received the same list 2 with the appropriate paradigmatic manipulation occurring on list 1. Four random orders were employed to minimize serial learning effects. Across the four random serial orders, R and W alternatives were presented equally often as left and right members of the pair with the limitation that no three successive items of the same function had the same spatial position.

Procedure. All Ss began practice on list 1 after instructions appropriate for the anticipation procedure. The pairs were presented at 2:2 second rate via a Lafayette memory drum with a 4 second intertrial interval. The words were presented in horizontal juxtaposition with S instructed to pronounce the item he believed was correct during the anticipation interval. The pair reappeared in the feedback interval with the correct item underlined.

Both list 1 and 2 were learned to a criterion of 2 successive perfect trials. After completion of first list to the criterion, Ss were fully informed about the relationship between the two lists in the instructed conditions. The Ss were also given examples (none of the words came from any list) to explain the relationship between the two lists. Subjects in the control groups were instructed that there was no relationship between the two lists. In noninstructed groups the Ss were not informed about any relationship of the materials to the first list. The first trial was conducted as a guessing trial for all Ss in list 1 and in list 2. After completion of learning of List 2, all Ss were given an associative matching retention test of List 1 similar to that employed by McGovern (1964) for paired-associate transfer. There was no time limit and S was instructed to guess when uncertain.

Results

List 1 Acquisition

2 x 4 x 4 analysis of variance for instructions, paradigms, and lists was performed on a number of trials to criterion for List 1. None of the main effects or their interactions were found to be significant (all $P_s >$

.10). An analysis of total errors to criterion yield similar results. Since lists were counterbalanced equally on all conditions and nonsignificant effects were obtained, these results indicate the lists were of equal difficulty and subsequent analyses omitted lists as a factor. Similarly, the lack of differences among the four paradigms indicates that any differences in performance which appeared on the second list could not be attributed to differences in first list difficulty.

List 2 Acquisition

Trials to criterion. Analysis of the number of trials to criterion in list 2 resulted in significant main effects for instructions, F (1, 88)= 9.95, $P < .002$; and paradigms, F (3, 88) = 6.60, $P < .0007$, and a nonsignificant interaction of the two variables ($P > .10$). The means and standard deviations respectively, were, 4.77 and 3.46 for instructed and 6.77 and 3.16 for noninstructed groups. Comparable measures for paradigms were 8.00, 4.36 (${}^{W}R_1$-${}^{R}W_1$); 4.42, 2.92 (W_2-${}^{R}W_1$); 4.71, 3.36 (${}^{W}R_1$-R_2); and 5.96, 1.37 (W_2-R_2). Newman-Keul's multiple comparisons revealed that subjects in the ${}^{W}R_1$-${}^{R}W_1$ paradigm took significantly more trials compared to all other paradigms ($Ps > .05$), which did not differ among the three. The lack of interaction with this dependent variable may be due to the relative insensitivity of trials to criterion as a measure of difficulty when using a recognition task. Perseveration errors have a direct effect on the number of trials to criterion and may thus dramatically attenuate differences between groups.

Total Errors. Analysis of variance of total errors to criterion yielded significant main effects for instruction, F (1, 88) = 11.35, $P < .001$; paradigms, F (3, 88) = 10.58, $P < .0001$, as well as significant interaction between instruction and paradigms, $\underline{F}$ (3, 88) = 2.75, $\underline{P} < .05$. The mean and standard deviations respectively were 5.95 and 7.96 for instructed and 10.54 and 7.60 for noninstructed groups. Comparable measures for paradigms were 10.96, 9.56 (${}^{W}R_1$-${}^{R}W_1$); 5.83, 7.29 (W_2-${}^{R}W_1$); 3.33, 4.47 (${}^{W}R_1$-R_2); and 12.88, 6.64 (W_2-R_2). The mean and standard deviations for the cells of the interaction effect are shown in Table 1. Newman-Keul's comparisons revealed that noninstructed subjects performed significantly poorer compared to instructed subjects in the W_2-${}^{R}W_1$ paradigm. No other paradigms differed significantly as a function of instructions. Comparisons of paradigms within the instructed condition revealed that the ${}^{W}R_1$-${}^{R}W_1$ paradigm produced significantly more errors relative to W_2-${}^{R}W_1$ and ${}^{W}R_1$-R_2, the latter of which did not differ from each other ($\underline{P} < .05$). The W_2-${}^{R}W_1$ and ${}^{W}R_1$-R_2 paradigms, however, produced significantly fewer errors compared to the control group ($\underline{P} < .01$), but the difference between ${}^{W}R_1$-${}^{R}W_1$ and control was nonsignificant. In the noninstructed conditions, the ${}^{W}R_1$-R_2 groups performed superior to the ${}^{W}R_1$-${}^{R}W_1$, W_2-${}^{R}W_1$ and W_2-R_2 groups (all $\underline{P}$s $< .05$). None of the latter three paradigms differed significantly.

Percentage of Transfer. In order to produce a comparison of the relative magnitudes of transfer effects among the conditions, the errors data of each subject was transformed to a percentage of transfer measure used by Read and Scarlett (1973) using the formula, $100 \times (\bar{c} - E)/(\bar{c} + E)$ in which the mean number of List 2 total errors for the appropriate W_2-R_2 condition was used as the control group ($\bar{c}$) value. Percentage of transfer on total errors on List 2 did not yield any negative transfer in any experimental paradigm. The percentages of transfer are shown in Table 2. The analysis of percentage of transfer on total errors corresponded with the results of the analysis of total errors to criterion. Significant effects occurred for instruction $\underline{F}$ (1, 66) = 23.68; $\underline{P} < .0001$ and paradigms $\underline{F}$ (2, 66) = 7.09; $\underline{P} < .002$, and the interaction of instruction and paradigms $\underline{F}$ (2, 66) = 3.03; $\underline{P} < .05$. Like the total errors measure, Newman-Keul's yielded significantly more positive transfer in W_2-$^RW_1$ paradigm with instructed subjects (92.99%) when compared to noninstructed subjects (16.30%). The other within paradigms effects for instructions were all nonsignificant. Within the instructed conditions, the $^WR_1$-$^RW_1$ paradigm yielded significantly less positive transfer than the W_2-$^RW_1$ and $^WR_1$-R_2 paradigms ($\underline{P}s < .05$) which did not differ from each other. Within the noninstructed conditions the $^WR_1$-R_2 paradigm produced more positive transfer than the $^WR_1$-$^RW_1$ and W_2-$^RW_1$ paradigms. The latter two paradigms clearly did not differ significantly.

Errors across trials. Errors across trials are shown in Figure 1 for instructed conditions and in Figure 2 for the noninstructed conditions. The experimental criterion for learning List 2 was two perfect trials and, therefore, no analysis could be done for errors by trials. Analysis for trials 1-8 for the $^WR_1$-$^RW_1$ and W_2-R_2 paradigms for the instructed condition and for trials 1-8 for all four paradigms for the noninstructed condition were conducted. The 2 x 8 analyses yielded a significant effect for trials, $\underline{F}$ (7, 154) = 29.05, $\underline{P} < .0001$, and for the interaction between groups by trials, $\underline{F}$ (7, 154) = 17.91, $\underline{P} < .0001$. The difference between paradigms was solely a result of the significant difference on trial one ($\underline{P} < .01$). The 4 x 8 analysis under the uninstructed condition produced significant effects for trials, $\underline{F}$ (7, 308) = 47.08, $\underline{P} < .001$, and, the group by trial interaction, $\underline{F}$ (21, 308) = 13.25, $\underline{P} < .0001$. Compared to the control group, the $^WR_1$-$^RW_1$ paradigm made significantly more errors on trials 1 and 2 ($\underline{P}s < .01$), but fewer errors on trial 7 ($\underline{P} < .05$). The W_2-$^RW_1$ paradigm was superior to the control group on trial 2 only ($\underline{P} < .05$) while

$^{W}R_1$-R_2 made fewer errors on trials 1 and 2 ($\underline{P}s < .01$), again relative to the control.

In order to make more specific tests for differences in the shape of the curves, orthogonal polynomials were used in tests for trends (Winer, 1971). Contrasts between paradigms were found for the linear and quadratic trends across the 8 trials for both instructed and noninstructed conditions. Means for each group and weighted means for linear and quadratic trends are shown in Table 3 for the instructed condition and in Table 4 for the noninstructed condition. The negative trend in the quadratic contrast indicates that the curve is concave downward and the positive trend indicates that the curve is concave upward. In the instructed conditions, the test for linear trends involving the paradigms employed in the above 2 x 8 analysis showed significant effects for trials, $\underline{F}$ (1, 22)= 69.75; $\underline{P} < .001$, and for the group by trial interaction, $\underline{F}$ (1, 22) = 26.25, $\underline{P} < .01$. The quadratic trend was significant for trials $\underline{F}$ (1, 22) = 18.98, $\underline{P} < .01$ and the group by trial interaction $\underline{F}$ (1, 22) = 24.73; $\underline{P} < .01$. In the noninstructed conditions the test for linear trends paralleling the 4 x 8 analysis reported earlier, showed a significant trials effect, $\underline{F}$ (1, 44) - 110.99; $\underline{P} < .0001$ and a significant group by trial interaction $\underline{F}$ (3, 44) = 64.65, $\underline{P} < .0001$. The quadratic trend was also significant for trials $\underline{F}$ (1, 44) = 62.07, $\underline{P} < .001$ and the group by trials interaction $\underline{F}$ (3, 44) = 21.62, $\underline{P} < .01$.

<u>Associative Matching Task</u>. A 2 x 4 analysis on the number of correct pairings associative matching task yielded only a significant paradigm effect, $\underline{F}$ (3, 88) = 14.60, $\underline{P} < .001$. The means and standard deviation respectively for paradigms were 9.73, 1.51 ($^{W}R_1$-$^{R}W_1$); 5.04, 2.78 (W_2-$^{R}W_1$); 5.17, 2.71 ($^{W}R_1$-R_2) and 6.20, 3.15 (W_2-R_2). Newman-Keul's comparison on

the mean showed that the matching of the ${}^{W}R_1$-${}^{R}W_1$ group was significantly superior to the W_2-${}^{R}W_1$, ${}^{W}R_1$-R_2, and W_2-R_2 groups (all $\underline{p}s < .01$). No other means differences were significant.

Discussion

Instructions in regard to paradigmatic relationships had facilitative effects on VD transfer performance only in the W_2-${}^{R}W_1$ paradigm. This result replicated that reported by Raskin et al. (1968), but fails to replicate the positive effects reported by Raskin et al. for the ${}^{W}R_1$-${}^{R}W_1$ paradigm. Superior performance of instructed subjects in the W_2-${}^{R}W_1$ paradigm was manifested from the very early trials as demonstrated in the analysis of list 2 errors across trials 1-8 of the W_2-${}^{R}W_1$.

As predicted from frequency theory, the W_2-${}^{R}W_1$ paradigm under the instructed condition produced significantly better performance than the control paradigm. However, in contrast to the frequency theory prediction, the W_2-${}^{R}W_1$ paradigm failed to be superior to the control condition under the noninstructed condition. Associative theory predicts interference due to incidental W-R associative competition. While the null difference under noninstructions may be viewed as evidence that such interference was operative, the failure to obtain negative transfer is consistent with the notion that Rule 1 mechanisms are sufficiently potent to minimize the effects of interference (Kanak and Dean, 1969). This argument was also supported by the analysis of percentage of transfer. In the W_2-${}^{R}W_1$ paradigm very high positive transfer (92%) occurred in the instruction condition, but was reduced drastically in the noninstructed condition (16%). Thus it seems apparent that when no instructive cue is available W-R associative interference interacts with Rule 1 type mechanism resulting in inferior performance in the noninstructed condition.

Results obtained in ${}^{W}R_1$-R_2 paradigm are contradictory to both frequency and associative theory. Under instructed as well as noninstructed conditions, ${}^{W}R_1$-R_2 showed positive transfer in comparison to the control group. These findings, however, do support Paul's differentiation-suppression hypothesis. The performance of subjects in this paradigm suggest that a listwide process of differentiating between the old R items of List 1 and the new R items of List 2, with a resultant "set" to suppress old R items, may have operated. It is likely that the high frequency accumulation of old R items served as a potent discriminative cue and allowed the subject to use higher order conceptual processes rather than frequency cues in the ${}^{W}R_1$-R_2 paradigm.

Frequency theory predicts better performance in W_2-${}^{R}W_1$ paradigm (Rule 1) compared to ${}^{W}R_1$-R_2 paradigm (Rule 2). This prediction was not supported. No significant difference was obtained between the two paradigms in the instructed condition, even though the trend is in the right direction. On the other hand, the Rule 2 ${}^{W}R_1$-R_2 group performed significantly superior to the W_2-${}^{R}W_1$ Rule 1 paradigm in the noninstructed condition. This is, of course, opposite of the prediction of frequency theory but the results are in accord with Paul's differentiation-suppression hypothesis as well as incidental associative interference, since strong W-R interference is activated in the W_2-${}^{R}W_1$ paradigm, while weaker R-W interference is operating in the ${}^{W}R_1$-R_2 paradigm. Likewise, the reduction in positive transfer was 76% in the W_2-${}^{R}W_1$ paradigm in comparing the noninstructed versus instructed conditions, while it was only 29% in the ${}^{W}R_1$-R_2 paradigm. This indicates further support for the differentiation-suppression and associative hypotheses.

Examination of Figures 1 and 2 shows better support for frequency theory in the W_2-$^{R}W_1$ and $^{W}R_1$-$^{R}W_1$ paradigm in the trends of errors across trials, in contrast to the total errors and percentage of transfer measures discussed above. Errors decreased more rapidly as trials progressed in the W_2-$^{R}W_1$ paradigm (Rule 1) compared to the control group. In the $^{W}R_1{}^{R}W_1$ paradigm (Rule 2) initial high positive transfer decreased sharply after a few trials with more errors occurring for this paradigm in the later trials than for the control group. These trends were substantiated by trend analyses. The significant interaction in the groups by trial analysis indicates that the two paradigms differ significantly for linear as well as quadratic components. Inspection of Figures 1 and 2 also shows a higher linear component in the W_2-R_2 paradigm, while a higher quadratic component (somewhat stronger under noninstruction) is observed in the $^{W}R_1$-$^{R}W_1$ paradigm. This presents stronger support for frequency theory than for incidental associative mechanisms.

It was predicted, based on the comparative frequency rates at the beginning of List 2 practice that initial positive transfer should decrease more slowly in $^{W}R_1$-R_2 than the $^{W}R_1$-$^{R}W_1$ paradigm, both in comparison to the control paradigm. Inspection of both Figures 1 and 2 supports this prediction.

The $^{W}R_1$-$^{R}W_1$ paradigm produced significantly superior associative matching than all other paradigms. It should be noted, however, that in this paradigm R and W items are involved in both lists with their functions reversed. The W-R and R-W associations are learned in acquisition of List 1 and List 2 resulting in little loss of associative recall in this paradigm, when an associative matching retention test is used. Studies supporting associative interference mechanisms typically have used modified free recall or modifiedmodified free recall task(e.g.,Kausler *et al.*, 1967; Kausler and Dean, 1967; Eschenbrenner, 1969). Thus the results obtained in the present experiments are prcbably a function of the retention test employed.

Experiment II

The multiple component analysis of the role of associative mechanisms is not supported as strongly in analogous of paried associate "backward" transfer paradigms as in "forward" transfer paradigms (e.g., Kausler and Dean, 1967; Kausler et al., 1967; and Kanak and Dean, 1969). The Kanak and Dean (1969) and Kanak and Knight (1974) studies have given very strong support to the associative interpretation in the noncorresponding (NC) pairing condition analogous to the A-B, A-Br transfer paradigm in paired associate learning. Experiment two is an extension of investigation of the NC paradigm to "backward" paradigms for testing additional predictions which can be obtained from a component analysis of VD transfer.

The three NC paradigms for VD transfer were contrasted with comparable corresponding (C) paradigms. The three basic interlist C paradigms selected for the contrast were W_1-R_1, ${}^{W}R_1$-${}^{R}W_1$ (analogous to A-B, B-A in PA transfer); W_1-R_1, ${}^{W}R_1$-${}^{R'}W_1$ (analogous to A-B, B-A'), and W_1-R_1, ${}^{W'}R_1$-${}^{R}W_1$ (analogous to A-B, B'-A).

According to frequency theory, ${}^{W}R_1$-${}^{R}W_1$ paradigm should initially use a Rule 2 strategy as explained in Experiment I, and show positive transfer followed by later negative transfer relative to the nonspecific control. Experiment I obtained substantial support for these predictions.

Since frequency theory does not make any prediction for the role of IAR in transfer condition, mediated items (e.g., ${}^{R'}W_1$ and ${}^{W'}R_1$) are treated as new items for frequency theory prediction.

The ${}^{W}R_1$-${}^{R'}W_1$ paradigm should also induce a Rule 2 strategy initially since W items in the second list were first list R items while ${}^{R'}W_1$ (i.e., the primary associate of the first list W item) will have zero frequency at the beginning of list two practice. Hence, in early trials there should be positive transfer followed by chance level performance and ultimately negative transfer relative to control group.

The ${}^{W'}R_1$-${}^{R}W_1$ paradigm allows use of a Rule 1 strategy since the R items of list two were wrong items in list one, while ${}^{W'}R_1$ (i.e., the primary associates of the first list R item) will have zero frequency. Hence, subjects will have advantage of frequency from the first list in this paradigm. The theory predicts initial positive transfer followed by a rapid approach to perfect performance.

It should be noted that although both ${}^{W}R_1$-${}^{R}W_1$ and ${}^{W}R_1$-${}^{R'}W_1$ paradigms provide for a Rule 2 strategy, initial frequency differences are not equal in the two paradigms in the second task. In the ${}^{W}R_1$-${}^{R}W_1$ paradigm there will be 3:1 frequency ratio for R and W items, respectively, while the ${}^{W}R_1$-${}^{R'}W_1$ paradigm will have a 3:0 frequency ratio for R and W items respectively in the beginning of the second list. It should therefore, require more trials to build an equal frequency between R and W items in the ${}^{W}R_1$-${}^{R'}W_1$ paradigm compared to ${}^{W}R_1$-${}^{R}W_1$. In other words, positive transfer should decrease more slowly in ${}^{W}R_1$-${}^{R'}W_1$ paradigm compared to ${}^{W}R_1$-${}^{R}W_1$ paradigm.

According to frequency theory, there should be no performance decrement between C and NC conditions in any of the three paradigms since frequency is accrued from List 1   is equated within a particular C vs. NC paradigmatic comparison.

According to associative interference account, the same predictions are made as in Experiment I for corresponding conditions in the ${}^{W}R_1$-${}^{R}W_1$ paradigm, while in the NC condition, there will be negative transfer from early trials and continued negative transfer as the trial progresses, as a result of bidirectional W-R and R-W interference. Based on prior literature, the decrement in NC performance might be expected to be greater under noninstructed conditions.

In the W_1-R_1, ${}^{W}R_1$-${}^{R'}W_1$ paradigm R-W associations should facilitate performance in the second list since the second list W item (which is the first list R item) elicits the first list W item, which indirectly mediates its associatively related item which is now the R item in the second list. However, W-R incidentally learned associations should yield interference in list 2 via the W item associate of list 1 (which is now list 2 R item), indirectly eliciting the R item of list 1 (now the W item in list 2), via $W'_1 \rightarrow W \rightarrow R_1$. Hence, there should be competition between "R_1" and "W_2". There is a greater rule effect according to Paul's interpretation in this paradigm. The second list W item will have greater differentiation due to functioning as a first list R item and subjects would use the conceptual rule of suppression of first list responses (R items).

In the ${}^{W'}R_1$-${}^{R}W_1$ paradigm, again R-W associations should facilitate performance in the second list since the second list W item (which is related to first list R item) elicits the first list R item, now indirectly mediates first list W items. These are not R items in the second list. However, W-R incidentally learned association should yield interference in list 2 via first list W items (which are now List 2 R items) indirectly eliciting the R item associates (now W item in list 2) via $W_1 - R_1 - R'_1$. Hence, there should be competition between "R'_1" and "W_2".

In all three paradigms incidental associative mechanisms would predict interference from competing W-R and R-W associations under conditions of re-pairing (NC) and hence negative transfer from early trials and continued negative transfer as trials progress.

According to the multiple component analysis (Kanak and Dean, 1969), of interacting frequency cue and associative mechanisms, incidental associations should interfere most in Rule 2 transfer situations and least in Rule 1 paradigms. Thus one would expect a greater decrement in the $^{W}R_1$-$^{R}W_1$ and $^{W}R_1$-$^{R'}W_1$ re-pairing paradigms than in the $^{W'}R_1$-$^{R}W_1$ re-pairing paradigm.

Method

Subjects. The *Ss* were 168 undergraduate students enrolled in introductory psyhcology classes at the University of Oklahoma. The students participated in the experiment as an option among class requirements and all were naive with respect to prior participation in verbal learning experiments. Twelve *Ss* were assigned by a randomized block procedure to each of 14 experimental conditions in the order of their appearance at the laboratory.

Design. The design was 3 x 2 x 2 factorial with 3 paradigms, two pairing variations (C and NC) for each interlist paradigm, and instruction vs. noninstruction as the third variable, making 12 independent groups. Two control groups W_1-R_1, W_2-R_2 were used, one with instructions and another noninstructed to serve as a nonspecific base line for evaluating specific transfer effects. The three paradigms were W_1-R_1, $^{W}R_1$-$^{R}W_1$; W_1-R_1, $^{W}R_1$-$^{R}W'_1$; and $^{W}R'_1$-$^{R}W_1$. In the $^{W}R_1$-$^{R}W'_1$ paradigm list 2 R items were primary word associates of list 1 W items while list 2 W items were list 1 R items. In the $^{W'}R_1$-$^{R}W_1$ paradigm list 2 R items were word associates of list 1 W items while list 2 R items were list 1 W items.

In the NC conditions List 2 items of C condition were re-paired in each transfer paradigm.

List. In Experiment II the same forty-eight items of Experiment I were used for the W_1-R_1 list and the W_2-R_2 list. One associatively related word was derived for each of 24 original pool of words used for W_1-R_1 in Experiment I for the ${}^{W'}R_1$-${}^{R}W_1$ and ${}^{W}R_1$- ${}^{R'}W_1$ paradigms. These 24 associated words were selected from Palermo and Jenkins (1964) and Shapiro and Palermo (1968). All words had a frequency count of A or AA on the Thorndike and Lorge (1944) G scale. The words were equated roughly on imagery ($\overline{X}$ = 5.01) from the Colorado Concreteness and Imagery norms (1973). The values for meaningfulness could not be obtained for these words but may be assumed to be relatively comparable due to their high frequency values.

For the ${}^{W'}R_1$-${}^{R}W_1$ paradigm first list R item words were replaced by their corresponding associate words, while for ${}^{W}R_1$-${}^{R'}W_1$ paradigm first list W items were replaced by their corresponding associate words. Like Experiment I, two sets (A & B) were constructed and two variants of A and B (A_1,A_2 B_1,B_2) were prepared by making A_1 an R item, A_2 a W item, and vice versa. Twelve Ss in each group were alternately assigned to A_1, A_2, B_1, B_2 subgroups (n = 3). All four sets were equally counterbalanced for list 1 and 2. Care was taken to minimize intralist associative relationships. All transfer groups received the same List 2 with the appropriate paradigmatic manipulation occurring on List 1. Four random orders were employed to minimize serial learning effects. Across the four random orders R and W alternative were presented equally as often as left and right members of the pair. Re-pairing of the ${}^{W}R_1$-${}^{R}W_1$, ${}^{W}R_1$-${}^{R'}W_1$ and

$^{W'}R_1$-$^{R}W_1$ generated the NC conditions for the three interlist paradigms.

Procedure. The general procedure for learning was the same as Experiment I in manner of presentation of material. List 1 learning was carried out to a criterion of 2 successive perfect trials while List 2 was learned for either 2 successive perfect trials or 10 trials, whichever occurred first. The subjects in the instructed group were explained the relationship for either C or NC after completion of list 1. After completion of list 2 learning, an associate matching recall test of List 1 was given as described in Experiment I.

Results

List 1 Acquisition

A 3 x 2 x 2 analysis of variance for paradigms, instructions, and C-NC conditions on the number of trials to criterion for List 1 was performed. None of the main effects or their interactions were found to be significant (all $Ps < .10$). Since the lists were equally counterbalanced for all groups and conditions in both lists, analyses on the four variations were not performed. An analysis of total errors to criterion yielded similar results. No significant differences among paradigms indicates that any difference in performance which appeared on the second list could not be attributed to differences in learning of the first list.

List 2 Acquisition

Trials to Criterion. Analysis of the number of trials to criterion in List 2 resulted in a significant main effects of C-NC conditions, F (1, 132) = 3.91, $P < .04$; of instructions, F (1, 132) = 7.35, $P < .007$; paradigms, F (2, 132) = 15.46, $P < .0001$. The interaction between C-NC and paradigms only approached significance, F (2, 132) = 15.46, $P < .07$. The means and standard deviations respectively, were 5.31 and 3.13 for the C and 6.21 and 2.75 for the NC conditions. Comparable measures for the instructed groups were 5.14 and 2.88 and 6.37 and 2.95 for noninstructed groups. Likewise, means and standard deviations respectively, for paradigms were 7.46, 2.62 (${}^{W}R_{1}-{}^{R}W_{1}$); 4.42, 2.84 (${}^{W}R_{1}-{}^{R'}W_{1}$); and 5.39, 2.62 (${}^{W'}R_{1}-{}^{R}W_{1}$).

Newman-Keul's multiple comparisons showed that subjects in the ${}^{W}R_{1}-{}^{R}W_{1}$ condition took significantly more trials to learn the list than ${}^{W}R_{1}-{}^{R'}W_{1}$ and ${}^{W'}R_{1}-{}^{R}W_{1}$ (both $\underline{P}s < .01$). The two latter paradigms did not differ significantly from one another. The mean and standard deviations, respectively, for the $W_{2}-R_{2}$ paradigm were 6.00 and 1.77. Dunnett's post-hoc test showed that the inferiority of ${}^{W}R_{1}-{}^{R}W_{1}$ and the superiority of the ${}^{W'}R_{1}-{}^{R}W_{1}$ both approached significance ($\underline{P}s < .10$), as compared to the control group. The trend toward an interaction of C and NC with paradigms resulted from significantly superior performance in the C condition under the ${}^{W}R_{1}-{}^{R}W_{1}$ and ${}^{W'}R1-{}^{R}W_{1}$ paradigms ($\underline{P}s < .05$). The means and standard deviations are shown in Table 5.

<u>Total Errors</u>. The analysis of variance ot total errors to criterion yielded significant main effects for C-NC conditions, $\underline{F}$ (1, 132) = 5.87, $\underline{P} < .01$; instructions, $\underline{F}$ (1, 132) = 15.12, $\underline{P} < .0001$; and paradigms, $\underline{F}$ (2, 132) = 12.79, $\underline{P} < .0001$. No interactions were significant. The means and standard deviations respectively, were 6.15 and 7.05 for C and 8.95 and 8.44 for the NC condition. Comparable measures were 5.31 and 6.80 for the instructed group and 9.81 and 8.27 for the noninstructed group. The means and standard deviations, respectively, for paradigms were 10.73, 8.48 (${}^{W}R_{1}-{}^{R}W_{1}$); 3.67, 5.34 (${}^{W}R_{1}-{}^{R'}W_{1}$); and 8.27, 7.92 (${}^{W'}R_{1}-{}^{R}W_{1}$). Newman-Keul's test showed the ${}^{W}R_{1}-{}^{R}W_{1}$ paradigm performed significantly poorer than the ${}^{W}R_{1}-{}^{R'}W_{1}$ paradigm and the ${}^{W}R_{1}-{}^{R'}W_{1}$ paradigm performed signifi-

cantly superior to the ${}^{W'}R_1$-${}^{R}W_1$ paradigm (all Ps $<.01$). No significant difference was obtained between the ${}^{W}R_1$-${}^{R}W_1$ and ${}^{W'}R_1$-${}^{R}W_1$ paradigms. All three paradigms were compared with the W_2-R_2 condition. The mean and standard deviation, respectively, for the W_2-R_2 paradigm were 13.29 and 5.34. Dunnett's multiple comparison test indicated significantly superior performacne in the ${}^{W}R_1$-${}^{R'}W_1$ paradigm ($\underline{P} < .01$) and the ${}^{W'}R_1$-${}^{R}W_1$ paradigm ($\underline{P} < .05$); compared to the control group.

Despite the insignificant interaction between paradigms and C-NC conditions, simple main effect was carried because a closer inspection of the data indicated that the lack of interaction was caused by equal performance in the ${}^{W}R_1$-${}^{R'}W_1$ paradigms in both C-NC condition significant main effect was produced for paradigms $\underline{F}$ (2, 132) = 12.79, $\underline{P} < .01$ and C-NC condition $\underline{F}$ (1, 132) = 5.875, $\underline{P} < .05$. C-NC conditions were significant ($\underline{P} < .01$) under ${}^{W}R_1$-${}^{R}W_1$ paradigm while approach was significant in ${}^{W'}R_1$-${}^{R}W_1$ ($\underline{P} < .10$).

<u>Percentage of Transfer</u>. Percentage of transfer on List 2 again corresponded with the results of the analysis of total errors. The analysis revealed significant main effects of C-NC conditions, $\underline{F}$ (1, 132) = 6.71, $\underline{P} < .01$; of instructions, $\underline{F}$ (1, 132) = 9.91, $\underline{P} < .002$, and of paradigms $\underline{F}$ (2, 132) = 13.87, $\underline{P} < .0001$. Newman-Keul's test indicated significantly higher positive transfer in the ${}^{W}R_1$-${}^{R'}W_1$ paradigm (67%) than the ${}^{W}R_1$-${}^{R}W_1$ (25%) and ${}^{W'}R_1$-${}^{R}W_1$ (38%) paradigms. The difference between the latter two paradigms was nonsignificant.

<u>Errors across Trials</u>. Errors across trials are shown in Figures 3 and 4 for instructed and noninstructed groups respectively. Separate analysis of errors on trials 1-8 were conducted for the ${}^{W}R_1$-${}^{R}W_1$ and W_2-R_2 paradigms for both instructed and noninstructed groups. Though the in-

struction condition did not interact with paradigms on total trials, instructions were retained as a factor to make the analysis comparable with Experiment I. The 2 x 8 analysis on the instructed conditions produced a significant difference for trials, $\underline{F}$ (7, 238) = 46.38, $\underline{P}$ · .001; and a significant group by trial interaction, $\underline{F}$ (7, 238) = 27.47, $\underline{P}$ .0001. Newman-Keul's multiple comparisons on the means revealed that ${}^{W}R_1$-${}^{R}W_1$ performed significantly poorer on trial 1 ($\underline{P} < .001$) and trial 2 ($\underline{P} < .01$) but performed superior on trials 5, 6, and 7 (all $\underline{P}s < .05$) when compared to the W_2-R_2 paradigm.

The 2 x 8 analysis for the noninstructed condition yielded a significant effect for trials, $\underline{F}$ (7, 238) = 46.38, $\underline{P} < .0001$, and a significant group by trial interaction, $\underline{F}$ (7, 238) = 27.47, $\underline{P} < .0001$. The ${}^{W}R_1$-${}^{R}W_1$ group performed significantly superior on trial 1 and 2 ($\underline{P}s < .01$) but inferior on trials 4 to 7 ($\underline{P}s < .05$) again, relative to the control group.

Like Experiment I, orthogonal polynomials were used in tests for trends (Winer, 1971). Contrasts between paradigms were found for the linear and quadratic trends across the 8 trials. Means for each group and weighted means for linear and quadratic trends are shown in Table 6 for the instructed condition and Table 7 for the noninstructed condition. In the instructed, as well as noninstructed, condition the test for a linear trend and a quadratic trench yielded a significant effect for trials and the group by trials interaction (all $\underline{P}s < .01$).

<u>Associative Matching Task</u>. A 2 x 2 x 3 analysis on the number of correct pairings in the associative matching task showed the C-NC main effects to be highly significant, $\underline{F}$ (1, 132) = 40.55, $\underline{P} < .0001$, and more importantly, the paradigm by C-NC interaction was significant, $\underline{F}$ (2, 132)= 7.16, $\underline{P}$ .001. The means and standard deviations are presented in Table 8.

Newman-Keul's test showed that the NC group recalled significantly fewer pairing than the C group in ${}^{W}R_1$-${}^{R}W_1$ paradigms. The other mean differences were nonsignificant.

Discussion

The NC condition produced significantly more List 2 errors than the C conditions. This was expected by the associative interference hypothesis and does not support the frequency theory. As in the first experiment, instructions with regard to the paradigmatic relationships had a facilitative effect. However, unlike Experiment I, the interaction of instructions and paradigm did not reach a significant level, nor did that of C-NC conditions and paradigms. Simple main effects revealed that ${}^{W}R_1$-${}^{R}W_1$ and ${}^{W'}R_1$-${}^{R}W_1$ paradigm produced significantly more errors in NC condition compared to its relative C condition. This supports associative hypothesis.

The ${}^{W}R_1$-${}^{R'}W_1$ paradigm produced considerably less errors than the two paradigms, a result in contrast with both frequency theory and the multiple component analysis. Both theories would expect poorer performance in this paradigm. However, the results do support Paul's differentiation-suppression hypothesis and are in agreement with the results of its functinally equivalent ${}^{W}R_1$-R_2 paradigm of Experiment I.

Frequency theory predicts better performance in the ${}^{W'}R_1$-${}^{R}W_1$ paradigm (Rule 1) compared to ${}^{W}R_1$-${}^{R'}W_1$ paradigm (Rule 2). This prediction was not supported. The ${}^{W'}R_1$-${}^{R}W_1$ paradigm, on the contrary, resulted in significantly more errors than the ${}^{W}R_1$-${}^{R'}W_1$ paradigm. Likewise the result of this comparison does not support the prediction of the associative interference hypothesis which predicts W-R associative interference in both the ${}^{W}R_1$-${}^{R'}W_1$ and ${}^{W'}R_1$-${}^{R}W_1$ paradigms. In the latter paradigm, however, the potency of W-R interference should be substantially mitigated by the Rule 1 cue and hence the associative theory leads to the expectation of better performance in the ${}^{W'}R_1$-${}^{R}W_1$ paradigm compared to ${}^{W}R_1$-${}^{R'}W_1$ paradigm.

The percentage of transfer measure on errors on List 2, relative to the control, did not reveal any negative transfer in any of the three experimental paradigms. However, only 25% positive (a value similar to the 26% observed in Experiment I) was obtained in the ${}^{W}R_1$-${}^{R}W_1$ paradigm which is significantly less than the 67% in the ${}^{W}R_1$-${}^{R'}W_1$ paradigm. Frequency theory predicts high positive transfer on the ${}^{W'}R_1$-${}^{R}W_1$ paradigm. Only 38% transfer was achieved, however. Thus incidental associative interference may have been activated in this paradigm via competition between W-R associations. The 38% transfer obtained in the ${}^{W'}R_1$-${}^{R}W_1$ paradigm is also significantly inferior to the 67% of the ${}^{W}R_1$-${}^{R'}W_1$ paradigm. This is, obviously, quite contradictory to the frequency theory.

Examination of Figures 3 and 4 shows better support for frequency theory in ${}^{W}R_1$-${}^{R}W_1$ and ${}^{W'}R_1$-${}^{R}W_1$ paradigms in the trends of errors across trials, in contrast the total errors and percentage of transfer measure discussed above. Errors decreased more rapidly as trials progressed in the ${}^{W'}R_1$-${}^{R}W_1$ paradigm compared to the control group. It again should be noted that this paradigm can be considered functionally equivalent to the W_2-${}^{R}W_1$ paradigm of Experiment I, since both are Rule 1 paradigms. Comparison of Figures 1 and 3 reveal that the W_2-${}^{R}W_1$ group had considerably less errors (in percentage of transfer, 54%) than the ${}^{W'}R_1$-${}^{R}W_1$ group (38%). It seems that some degree of W-R interference is activated in the ${}^{W'}R_1$-${}^{R}W_1$ paradigm.

The ${}^{W}R_1$-${}^{R'}W_1$ paradigm shows the same percentage (67%) of positive transfer as its functionally equivalent ${}^{W}R_1$-R_2 paradigm does in Experiment I. Both paradigms support Paul's differentiation-suppression hypothesis. The significant interactions of linear and quadratic trends for groups by trials indicates that the paradigms differ significantly in linear as well as quadratic components. Inspection of Figures 3 and 4 shows a stronger linear component in the W_2-R_2 and ${}^{W'}R_1$-${}^{R}W_1$ paradigms, while a stronger quadratic component is evident in the ${}^{W}R_1$-${}^{R}W_1$ paradigm. This presents stronger support for the frequency theory than incidental associative mechanisms.

Analysis of total error and percentage of transfer indicates stronger support for associative hypothesis while analysis of errors across trials supports the frequency theory. These conflicting results are further discussed in the general discussion.

Acquisition data supports frequency theory in the ${}^{W}R_1$-${}^{R}W_1$ paradigm, but not under the NC conditions. The ${}^{W}R_1$-${}^{R}W_1$ paradigms produced significant loss in the retention of List 1 correct pairings in the NC condition relative to the C condition. Since in associative matching task both W and R items are "available," the loss of retention in the NC paradigm represents support for incidental associative interference mechanisms. Frequency theory as stated, makes no prediction of differential List 1 retention for the C and NC conditions.

General Discussion

The results of the two experiments cannot be interpreted within any single one of the three theories dicussed in the introduction section. Different paradigms produced results in support of different theories. Frequency theory was supported strongly in the Rule 1 W_2-${}^{R}W_1$ paradigm when subjects were instructed about paradigmatic relationships. However, the high magnitude of positive transfer (92%) could also be interpreted as supporting an extension of Paul's differentiation-suppression hypothesis under the ruberic of subjects learning a concept of "release" of suppression (i.e., always respons with the previously suppressed alternative). In the Rule 2 ${}^{W}R_1\text{-}{}^{R}W_1$ paradigm under the C condition, frequency theory was supported in Experiment I in demonstrating positive transfer, relative to $W_2\text{-}R_2$, on the early trials and negative transfer on the later trials. The same trend appeared in Experiment II in the C conditions, but associative theory perhaps better explains the lesser degree of positive transfer on the early trials and greater negative transfer on later trials for the NC condition.

associative theory was supported strongly in the $W_2\text{-}{}^{R}W_1$ paradigm when subjects were not instructed and in the ${}^{W}R_1\text{-}{}^{R}W_1$ paradigm under the NC condition. Paul's differentiation suppression hypothesis drew strong support in the ${}^{W}R_1\text{-}R_2$ and ${}^{W}R_1\text{-}{}^{R'}W_1$ paradigms in both the instructed and noninstructed conditions as well as the C-NC conditions.

The results are even more confusing when compared under different dependent measures, especially when percentage of transfer on total errors are compared with errors across trials. For example, ${}^{W'}R_1\text{-}{}^{R}W_1$ supports frequency theory when the data are analyzed for errors across trials. However, the analysis of percentage of transfer showed only 38% positive transfer for this Rule 1 paradigm compared to 68% transfer for the Rule 1 ${}^{W}R_1\text{-}R_2$ paradigm, a result in obvious contrast with the prediction of frequency theory.

The analysis of errors across trials in the ${}^{W}R_1\text{-}{}^{R}W_1$ paradigm supports frequency theory in both experiments, qualified only by support for associative theory under the NC condition. In contrast, analysis of total errors results in a signficant main effect of C vs. NC indicating inferior VD performance under the NC condition. However, a simple main effect analysis on the same measure, despite the nonsignificant paradigm by C-NC interactions revealed that the inferiority of NC relative to C paradigms was mainly due to the effect in the ${}^{W}R_1$-${}^{R}W_1$ and ${}^{W'}R_1$-${}^{R}W_1$ paradigms. These results are in support of associative interference hypothesis and against the frequency theory.

The overall pattern of results indicates that no single theory can account for the results of all the paradigms under instructed and non-instructed conditions and C-NC conditions.

REFERENCES

Eckert, E. & Kanak, N.J. Verbal discrimination learning: A review of the acquisition, transfer and retention literature through 1972. Psychological Bulletin, 1974, 81, 582-607.

Edwards, A. L. Experimental Design in Psychological Research. New York: Holt, Rinehart and Winston, Inc., 1960.

Ekstrand, B. R., Wallace, W. P. & Underwood, B. J. A frequency theory of verbal discrimination learning. Psychological Review, 1966, 73, 566-578.

Eschenbrenner, A. J., Jr. Retroactive and proactive inhibition in verbal discrimination learning. Journal of Experimental Psychology, 1969, 81, 576-583.

Eschenbrenner, A. J., Jr. & Kausler, D. H. Unlearning of List 1 wrong items in verbal discrimination transfer. Journal of Experimental Psychology, 1968, 78, 696-698.

Kanak, N. J. & Dean, M. F. Transfer mechanisms in verbal discrimination. Journal of Experimental Psychology, 1969, 79, 300-307.

Kanak, N. J. & Knight, J. M. The re-pairing decrement in verbal discrimination transfer: Further evidence favoring associative mechanisms. Journal of Experimental Psychology, 1974, 103, 304-309.

Kausler, D. H. Mechanisms for transfer in verbal discrimination tasks. Invited paper presented at the meeting of the Southwestern Psychological Association, Arlington, Texas, April, 1966.

Kausler, D. H. Psychology of Verbal Learning and Memory. New York: Academic Press, 1973.

Kausler, D. H. & Dean, M. G. Supplementary report: Direct and mediated transfer for right and wrong responses in verbal discrimination learning. Journal of Verbal Learning and Verbal Behavior, 1967, 6, 672-674.

Kausler, D. H. & Farzanegan, F. Word-frequency and selection strategies in verbal-discrimination learning. Journal of Verbal Learning and Verbal Behavior, 1969, 8, 196-201.

Kausler, D. H., Fulkerson, F. E. & Eschenbrenner, A. J., Jr. Unlearning of list I right items in verbal discrimination transfer. Journal of Experimental Psychology, 1967, 75, 379-385.

McClelland, D. C. Studies in serial verbal discrimination learning. II Retention of response to right and wrong words in transfer situation. Journal of Experimental Psychology, 1942, 31, 149-162.

McLaughlin, B. Intentional and incidental learning in human subjects: The role of instructions to learn and motivation. Psychological Bulletin, 1965, 63, 359-376.

Osgood, C. E. The similarity paradox in human learning: A resolution. Psychological Review, 1949, 56, 132-143.

Paivio, A., Yuille, J. C. & Madigan, S. Concreteness, imagery, and meaningfulness values for 925 nouns. Journal of Experimental Psychology, 1968, 76, (1, Pt. 2).

Paul, C. Verbal discrimination reversal as a function of overlearning and percentage of items reversed. Journal of Experimental Psychology, 1966, 72, 271-275.

Paul, C. Verbal discrimination reversal as a function of overlearning and percentage of items reversed: An extension. Journal of Verbal Learning and Verbal Behavior, 1968, 7, 270-272.

Paul, C. Acquired equivalence of correct alternatives after verbal discrimination learning. Journal of Experimental Psychology, 1970, 86, 123-125.

Paul, C. & Callahan, C. Effects of overtraining on verbal discrimination shifts: A differentiation-suppression hypothesis. Journal of Experimental Psychology, 1972, 92, 198-206.

Paul, H. Ratio of correct to incorrect alternatives: A test of the frequency hypothesis of verbal discrimination learning. Journal of Experimental Psychology, 1971, 88, 285-286.

Paul, H. Verbal discrimination learning: A distinction between frequency and frequency-rule effects. Journal of Experimental Psychology, 1972, 94, 343-344.

Raskin, D. C., Boice, C., Rubel, E. W., & Clark, D. Transfer tests of the frequency theory of verbal discrimination learning. Journal of Experimental Psychology, 1968, 76, 521-529.

Read, J. D. & Scarlett, J. R. Effect of stimulus and response meaningfulness on free-pairing paired-associate transfer. Journal of Experimental Psychology, 1973, 97 (3), 287-291.

Sardello, R. J. & Kausler, D. H. Associative recall in verbal discrimination learning as related to pronunciation and degree of practice. Psychonomic Science, 1967, 8, 253-254.

Shapiro, S. I. & Palermo, D. S. Conceptual organization and class membership: Normative data for representatives of 100 categories. Psychonomic Science Monograph Supplements, 1970, 3, No. 11 (Whole No. 43).

Ulrich, J. R. Re-pairing, number of alternatives, and meaningfulness in verbal discrimination learning. Journal of Experimental Psychology, 1972, 96, 201-203.

Underwood, B. J., Jesse, F. & Ekstrand, B. R. Knowledge of rights and wrongs in verbal discrimination learning. Journal of Verbal Learning and Verbal Behavior, 1964, 3, 183-186.

Wallace, W. P. & Nappe, G. W. Re-pairing Rights and Wrongs in verbal discrimination learning. Journal of Experimental Psychology, 1971, 87, 355-360.

Wallace, W. P., Remington, R. K. & Beito, A. Retroactive inhibition as a function of transfer paradigm in verbal discrimination. Journal of Experimental Psychology, 1972, 96, 463-465.

Weiner, B. J. Statistical Principles in Experimental Design. New York: McGraw-Hill Book Company, Second Edition, 1971.

TABLE 1

Means and Standard Deviation for List 2 Total Errors in

Experiment I

	Paradigm							
	${}^{W}R_1$-${}^{R}W_1$		W_2-${}^{R}W_1$		${}^{W}R_1$-R_2		W_2-R_2	
	Mean	S-D	Mean	S-D	Mean	S-D	Mean	S-D
Instruction	8.50	8.80	.583	.667	1.67	2.90	13.08	7.85
Noninstruction	13.42	9.18	11.08	6.99	5.00	5.24	12.67	5.52

TABLE 2

Percentage of Transfer for List 2 Total Errors in Experiment I

	${}^{W}R_1-{}^{R}W_1$	$W_2-{}^{R}W_1$	${}^{W}R_1-R_2$
Instruction	41.16	92.99	82.41
Noninstruction	12.14	16.30	53.97

TABLE 3

The Means and Weighted Means for Linear and Quadratic Contrasts for Instructed Subjects in Experiment I

	Trials							
	1	2	3	4	5	6	7	8
$W_{R_1}-R_{W_1}$ M	1.25	1.92	1.75	1.00	.83	.83	.58	.5
Linear	-8.75	-9.58	-5.25	-1.0	.83	2.5	2.92	3.5
Quad	8.75	1.91	-5.25	-5.0	-4.17	-25	.58	3.5
W_2-R_2 M	6.42	3.08	1.42	.92	.75	.33	.17	.17
Linear	-44.67	-15.42	-4.0	-1.08	.75	1.0	.83	1.16
Quad	44.67	3.08	-4.5	-5.42	-3.75	-1.0	.16	1.67

TABLE 4

The Means and Weighted Means for Linear and Quadratic Contests for Noninstructed Subjects in Experiment I

		Trials							
		1	2	3	4	5	6	7	8
${}^{W}R_1-{}^{R}W_1$	M	1.33	1.17	1.08	1.58	1.50	1.58	1.75	1.0
	Linear	-9.33	-5.83	-3.25	-1.58	-1.50	4.75	8.75	7.0
	Quad	9.33	1.33	-3.25	-7.92	-7.5	-4.75	1.75	7.0
$W_2-{}^{R}W_1$	M	4.58	1.83	1.75	.92	.50	.50	.42	.33
	Linear	-32.08	-9.16	-5.25	-.92	.50	1.5	2.08	2.33
	Quad	32.08	1.83	-5.25	-4.58	-2.5	-1.5	.42	2.33
${}^{W}R_1-R_2$	M	1.5	.75	.75	.42	.75	.33	.08	.33
	Linear	-10.5	-4.16	-2.25	-.42	.75	1.00	.42	2.33
	Quad	10.5	.83	-2.25	-2.08	-3.75	-1.0	.08	2.33
W_2-R_2	M	5.75	3.75	1.50	.67	.33	.33	.16	.0
	Linear	-40.25	-18.75	-4.5	-.67	.33	1.0	.83	.0
	Quad	40.25	3.75	-4.5	-3.33	-1.66	-1.0	.67	.0

TABLE 5

Means and Standard Deviations for List 2 Trials

to Criterion in Experiment II

	Paradigm					
	$^{W}R_1$-$^{R}W_1$		$^{W}R_1$-$^{R'}W_1$		$^{W'}R_1$-$^{R}W_1$	
Corresponding	6.67	3.37	4.71	1.27	4.54	2.32
Noncorresponding	8.25	1.21	4.13	2.40	6.25	2.71

TABLE 6

The Means and Weighted Means for Linear and Quadratic Contrast in Paradigms for Errors per Trial on List 2 for Instructed Subjects in Experiment II

		Trials							
		1	2	3	4	5	6	7	8
$W_{R_1}-R_{W_1}$	$\bar{X}$	.71	1.38	1.42	1.04	1.67	.71	.79	.38
	Linear	-4.96	-6.88	-4.25	-1.04	1.21	2.13	3.96	2.63
	Quad	4.96	1.37	-4.25	-5.21	-5.63	-2.13	.79	2.63
W_2-R_2	M	.56	3.50	1.50	.33	.50	.25	.08	.00
	Linear	-39.67	-17.58	-4.50	-.33	.50	.75	.42	0
	Quad	39.67	3.50	-4.50	-1.67	-2.50	-.75	.08	0

TABLE 7

The Means and Weighted Means for Linear and Quadratic Contrasts in Paradigms for Errors per Trial on List 2 for Noninstructed Subjects in Experiment II

		Trials							
		1	2	3	4	5	6	7	8
W_{R_1}-R_{W_1}	M	1.79	1.88	1.96	1.71	1.29	1.46	1.13	1.00
	Linear								
	Quad	12.54	2.33	-5.79	-8.13	-6.92	-4.21	1.13	7.0
W_2-R_2	M	5.83	3.67	2.75	1.42	.42	.25	.17	.08
	Linear	-40.83	-18.33	-8.25	-1.12	.42	.75	.83	.58
	Quad	40.83	3.67	-8.25	-7.08	-2.08	-.75	.17	.58

TABLE 8

Mean and Standard Deviation for Associative

Matching Recall of List 1 in Experiment II

	W_{R_1}-R_{W_1}		W_{R_1}-R'_{W_1}		W'_{R_1}-R_{W_1}	
	Mean	S-D	Mean	S-D	Mean	S-D
Corresponding	8.96	3.17	6.71	2.43	6.54	3.77
Noncorresponding	2.88	2.68	4.75	3.25	4.67	2.66

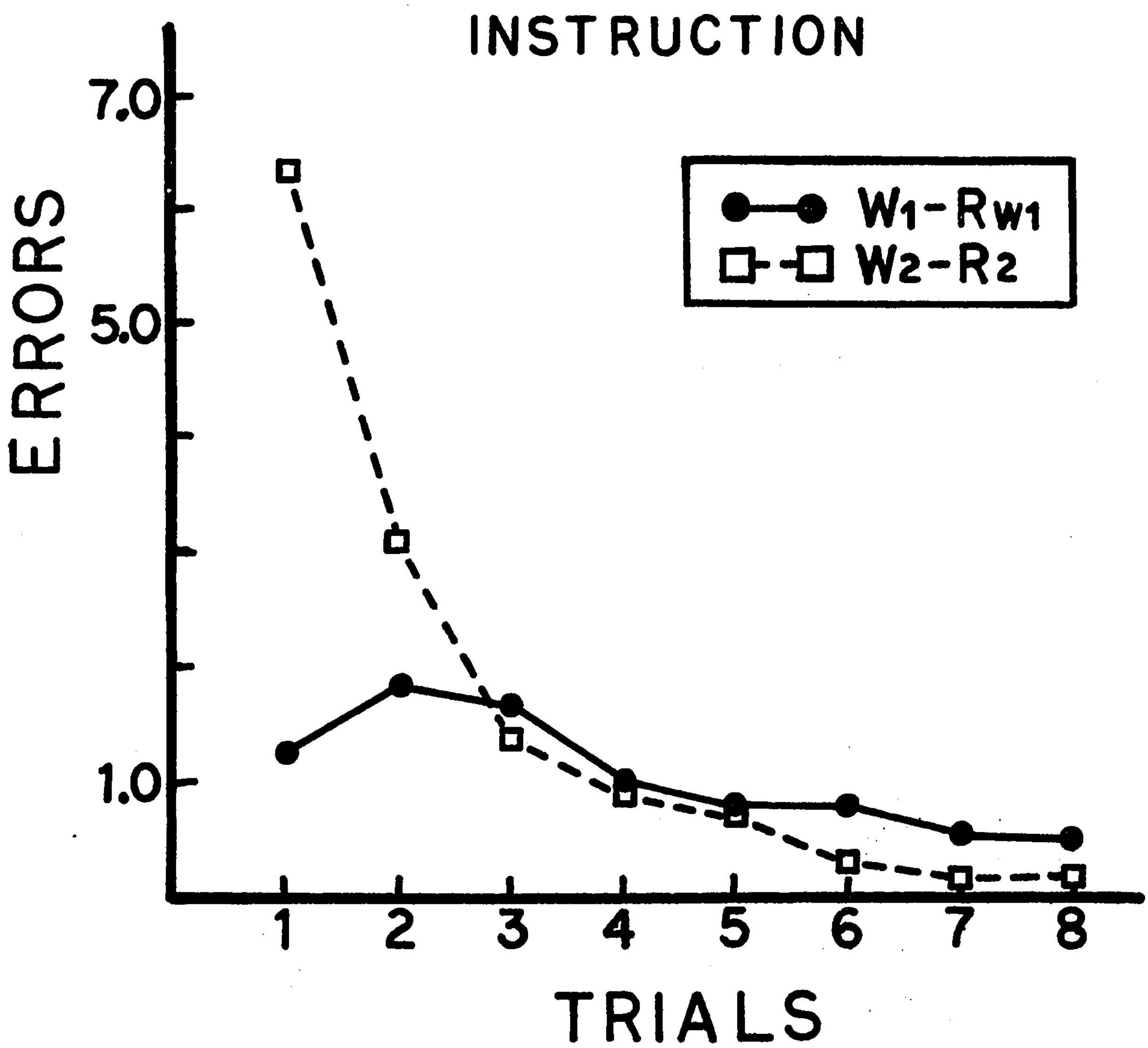
Figure Captions

Figure 1. Total errors across trials 1-8 for the $^{W}R_1$-$^{R}W_1$ and W_2-R_2 paradigms in instructed conditions in Experiment I.

Figure 2. Total errors across trials 1-8 for the $^{W}R_1$-R_W, W_2-$^{R}W_1$, $^{W}R_1$-R_2 and W_2-R_2 paradigms in noninstructed conditions in Experiment I.

Figure 3. Total errors across trials 1-8 for the $^{W}R_1$-$^{R}W_1$ and W_2-R_2 paradigms in instructed conditions in Experiment II.

Figure 4. Total errors across trials 1-8 for the $^{W}R_1$-$^{R}W_1$ and W_2-R_2 paradigms in noninstructed conditions in Experiment II.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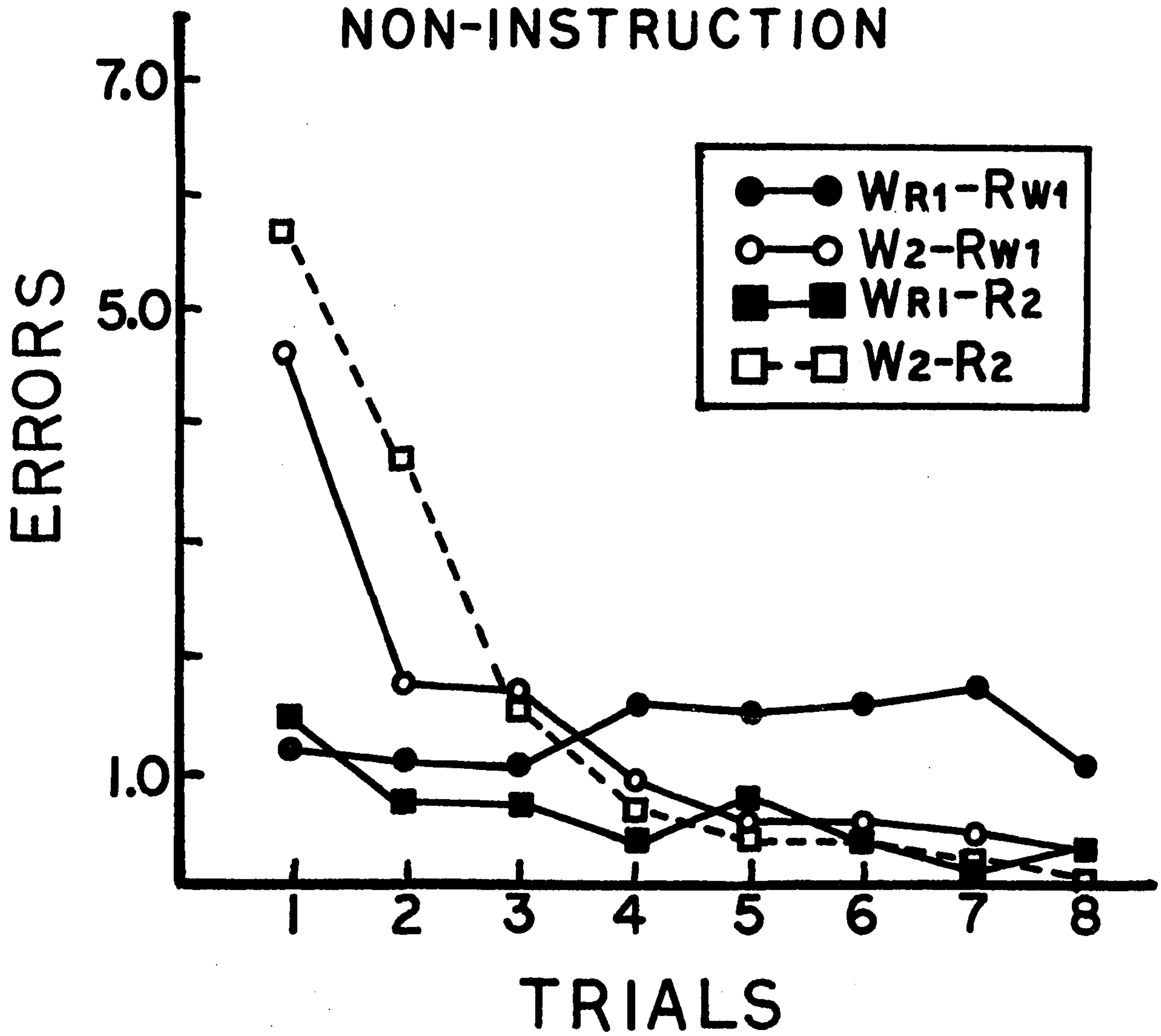
TRIALS
W1-RW1
W2-R2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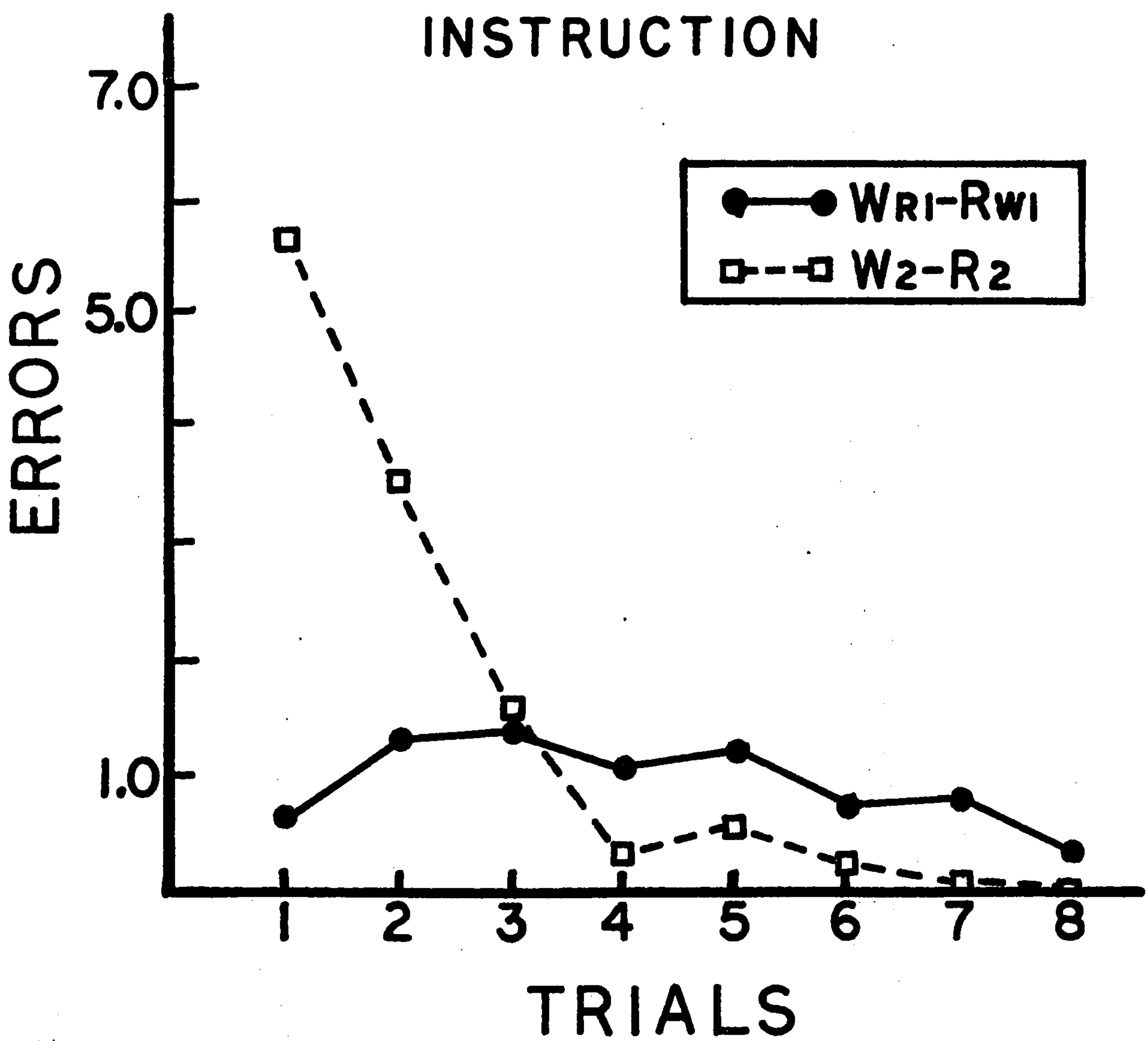
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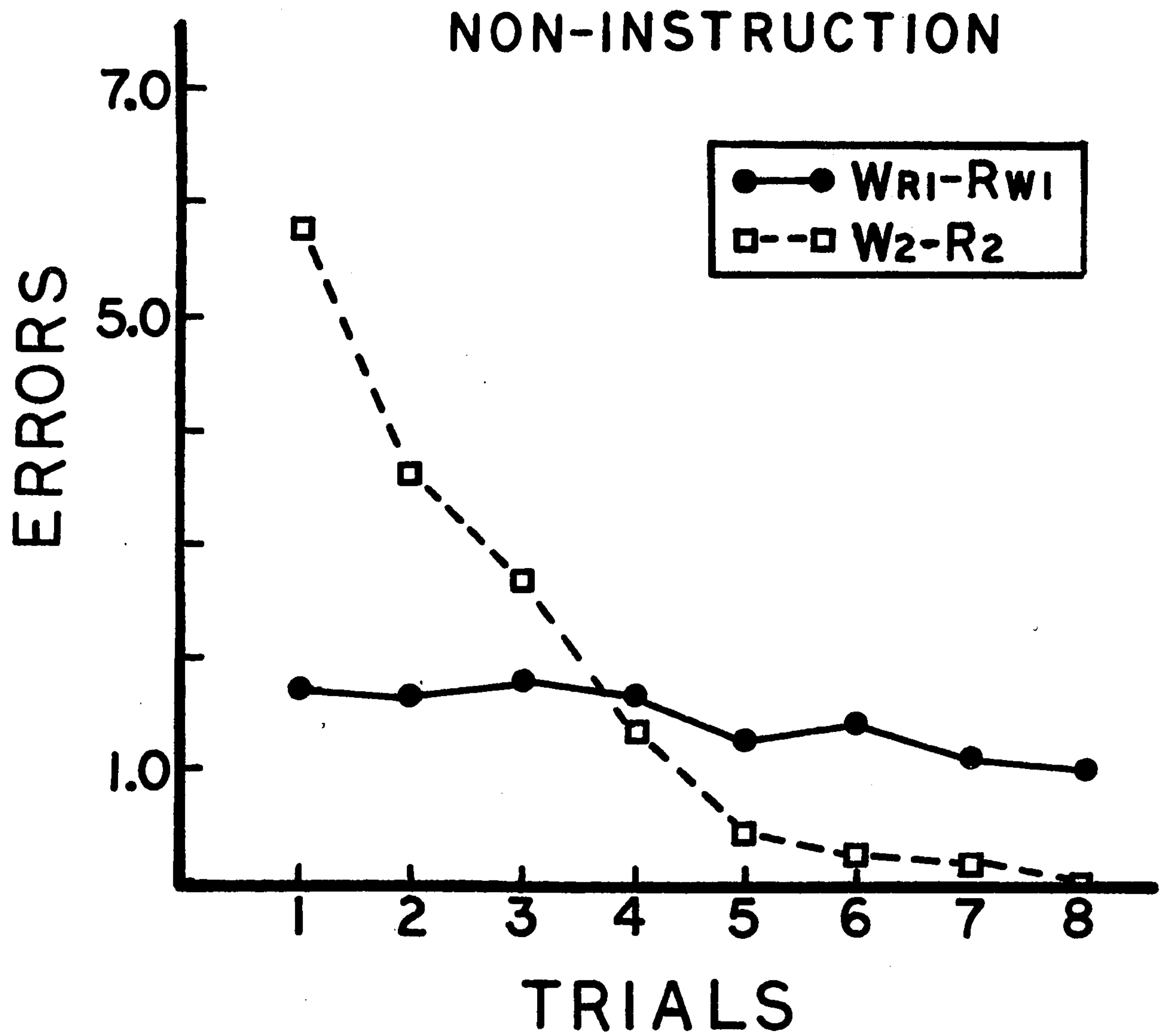
TRIALS



NON-INSTRUCTION
7.0
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ERRORS
WR1-RW1
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TRIALS

APPENDIX A

PROSPECTUS

PROSPECTUS

A transfer study generally contains two basic experimental stages consisting of a training stage and a test stage. The main purpose in a transfer study is to examine how training given during the first stage influences performance during the test stage. The observed effect may be zero, positive or negative. In other words, the training stage may fail to influence performance in the test situation, facilitate it, or interfere with it. The presence of a significant transfer effect, whether positive or negative, implies that some of the responses established during the training stage are carried over to the test stage. The positive or negative transfer effects depend on whether these responses carried over from training stages are appropriate or inappropriate to the test stage. Hence, experiments on transfer emphasize the similarities and differences between the two tasks.

One of the major developments in contemporary research on transfer has been the recognition that two sources of transfer contribute to the gross transfer effect: nonspecific and specific. A nonspecific transfer effect is independent of list content. There is no stimulus-response relationship employed between the training and test stages. Nonspecific transfer effects arise from general factors such as warm-up or learning to learn. In other words, during the training stage subjects acquire some general skills and postural adjustments which enable them to adjust more rapidly during the testing stage.

Transfer effects are designated as specific when some stimulus-response relationship exists between the two stages. Most investigators have shown an interest in differentiating the specific and nonspecific effect. In order to establish laws of specific transfer it is necessary to experimentally determine the stimulus-response relationships between the two stages and vary them systematically.

Specific Transfer Effect

Poffenberger (1915) proposed three transfer laws: (1) Transfer effects are positive when both its stimuli and responses remain the same in the two stages (A-B, A-B paradigm); (2) transfer effects are negative when the stimuli remain the same but its responses change in the two stages (A-B, A-C paradigm); (3) transfer effects are zero when the stimuli and responses change in both stages (A-B, C-D paradigm). Wylie (1919) added a fourth law, namely that (4) transfer effects are positive when the stimuli changes and responses remain the same (A-B, C-B paradigm). Bruce (1933), varying both stimulus and response similarity in nine different paradigms, using CVC materials, supported all four transfer postulates. This design, however, does prohibit generalizations since paradigmatic manipulation occurred in the second list. The study does represent one of the first attempts to investigate specific transfer effects via paradigmatic variation in the two stages.

The principle of stimulus generalization has proven to be a significant tool in the theoretical analysis of specific transfer effects.

Stimulus Similarity

Gibson's (1940) theory on stimulus generalization postulates that generalization occurs among verbal stimuli and the reduction of generalization (differentiation) is an essential condition in a transfer learning task. Generalization can be reduced by reinforcing differentiational responses (correct responses) and by not reinforcing generalized responses. Hence, the greater the degree of generalization the more reinforced practice is required to establish differentiation.

According to Gibson, stimulus generalization occurs not only within lists but also between lists. When there is generalization between the stimulus terms in two lists, the first list responses will be elicited during second list learning.

Specific predictions from Gibson's hypothesis were tested by Hamilton (1943) and Gibson (1941). Hamilton used identical sets of nonsense syllables as responses in both lists but varied 4 degrees of stimulus similarity using Gibson's visual forms. These four conditions were denoted as A-B, A-B; A-B, A'-B; A-B, A"-B; and A-B, C-B. Hamilton found that, as similarity between the two stages decreases (A-B to C-B second list), positive transfer decreases. In other words, increased stimulus generalization results in increasing positive transfer when responses are identical in both lists.

Gibson (1941) used the same stimulus similarity conditions as Hamilton but used different responses in the testing stage. Thus, four conditions were denoted as A-B, A-D; A-B, A'-D; A-B, A"-D; and A-B, C-D. Gibson found negative transfer when second list responses were different. He also found that the greater the similarity between stimuli the greater the negative transfer. Postman (1971) pointed out that from these two studies it can be concluded that the direction of transfer, positive or negative, is determined by response similarity while the magnitude of transfer represents some function of stimulus similarity. Both Bugelski and Cadwallader (1956) and Dallett (1962) failed to support the stimulus generalization hypothesis. They showed a gradient for positive transfer paradigms but not for negative transfer paradigms.

Underwood (1961) has criticized the Gibson hypothesis for its methodological and theoretical perspective. First, the stimuli used in these experiments were derived from normative data. Any experiment using such stimuli is thus validating the normative test itself rather than a test of inter-stimulus generalization effects on transfer. Secondly, stimuli were of geometrical forms. This limits the knowledge regarding the stimulus generalization effect with nonsensory stimuli and verbal materials.

Gibson's theory is incomplete because it did not take into account the role of response generalization. Osgood (1949) takes into account both types of generalizations in his promary laws of transfer surface.

Response Similarity

Osgood's transfer surface:

Using the data obtained by Gibson and Hamilton and in his own laboratory, Osgood (1949) proposed a model of the effects of interlist stimulus and response similarity. The vertical dimension of the model provides an estimate of the amount and direction of transfer. The flat rectangular surface on the horizontal plane represents zero transfer. The following three empirical laws were derived from this surface:

(1)When stimuli are identical (SI) and R are varied (RI to Ra), negative transfer and retroactive interference are obtained, the magnitude of both decreasing as the similarity between responses increases (A-C varied to A'-B to A-B).

(2)When responses are identical (RI) and stimuli are varied (SI-SN), positive transfer and retroactive facilitation are obtained, the magnitude of both increasing as the similarity between stimulus members increases

(C-B varied to A-B). this law was supported by Hamilton's (1943) result.

(3)When both stimuli and responses are simultaneously varied, negative transfer and retroactive interference are obtained, the magnitude of both increasing as the stimulus similarity increases (C-D varied to A-C).

The surface represented an important systematic attempt to integrate the total range of transfer and interference phenomena. Direct attempts to validate Osgood's net transfer have produced mixed results.

Bugelski and Cadwallader (1956) made a test of Osgood's model by varying 4 degrees of stimulus and response similarity. They used geometrical forms as stimuli and adjectives as responses in paired-associate lists. Interlist stimulus similarity was varied from identity to similarity to less similarity and neutrality. Interlist responses were identical, similar, neutral and opposed. The results were in complete harmony with Osgood's first empirical law. The second law was not supported. Similar responses showed the greatest negative transfer and negative transfer effects decreased with decreasing response similarity (Rn, Ro) instead of increasing as Osgood's model would predict. Osgood's third law was supported in the present experiment. When both stimuli and responses were varied simultaneously, the magnitude of negative transfer increased as similarity was increased. A possible reason for the nonconfirmations may have been that the lists were not counterbalanced. It is possible that transfer tasks were more difficult in some conditions (underwood, 1961).

Dallett (1962) carried out an experiment to test Osgood's second law which was not supported by Bugelski and Cadwallader (1956). She had 3 degrees of response similarity: identical, similar, and neutral. She also had 4 degrees of stimulus similarity: SI, S_1, S_2, Sn. Results were in agreement with the prediction from Osgood's surface. Performance was better with similar rather than with neutral responses. This finding differs from Bugelski et al. where performance was worse with similar responses.

Wimer (1964) factorially varied 5 degrees of stimulus and response similarity using Osgood's original material to both test and extend the net transfer surface. Support for law 1 was minimal when stimuli on both lists were identical or similar. Positive transfer occurred for opposed and antonymous responses (according to Osgood, there should have been a negative transfer) as well as identical and similar responses.

Osgood's second law was supported when responses were identical on both lists. Only a high degree of stimulus similarity produced positive transfer. Results were contrary to Osgood's third law prediction. There was evidence for positive transfer for all conditions. Transfer between lists appears to increase as similarity or opposition relation increases.

For each of the empirical laws postulated by Osgood, support was minimal when stimulus relations were held constant and response similarity was varied (Law 1), and maximal when reponse similarity was constant and stimulus similarity varied (Law 2). There was little support for the third law. When net transfer is depicted with responses varying only from RI to RN, data are in approximate accord with Osgood's predictions. There is substantial evidence that as the responses become more similar the acquisition of a transfer list is increasingly facilitated (Morgan and Underwood, 1950; Underwood, 1951; Young, 1955; and Staner, 1956).

The Osgood surface, therefore, generates many theoretical implications when S_1-S_2 and R_1-R_2 relations are varied from identity to neutrality. It should be noted, however, that Osgood's transfer surface considers only gross transfer effects and lacks the theoretical formulation necessary to deal with interactions with seconday variables. This theoretical formulation has been taken in account in a component process model of transfer proposed by Martin (1965).

Stage Analysis Model

Underwood, Runquist and Schulz (1959) attempted to take the first step in identifying separate component stages in PA learning. The two-stage model assumes that PA acquisition has (1) A response availability stage and (2) an associative or hook-up stage. In the response availability stage the subject acquires responses while in the hook-up stage the subject learns to associate the available responses with presented stimuli. According to this model then, responses must become available before they enter into new associations. Nonspecific transfer effects may influence both stages of acquisition and are assumed to be present for all paradigms.

Martin's Component Process Model

Two-stage analysis assumes a hook-up of only forward associations. Martin's (1965) component model considers the hook-up or associative stage as consisting of forward as well as backward associations. Martin's component surface conceptualizes three components which are transferred from one paired associate task to another. The three components are (1) response availability (R) (2)Forward associations (F) and (3)Backward associations (B). According to Martin, what is transferred is some combination of these three effects. Rather than employing a net transfer surface, Martin argued that an accurate depiction of transfer must involve three surfaces which describe how a particular effect is transferred as a function of the position within the coordinate system of that particular surface.

According to the R surface, positive transfer will be maximal when responses are identical (A-B, A-B and A-B, C-B). The positive transfer effect declines progressively from maximum to zero as the relation between the successive responses changes from identity to dissimilarity (A-B, A-C and A-B, C-D). It should be noted that the R surface only contributes positively to the second list acquisition and the net transfer effect is independent of the degree of stimulus similarity.

Martin's F surface predictions are equivalent to those provided by Osgood's surface. Forward associative learning (FA) produces negative transfer when the second list stimuli elicit first list responses (A-B, A-C). Thus F surface depends on S_1-S_2 relationships. Therefore A-B, C-B and A-B, C-D paradigms are not involved in the transfer of FA because there is a neutral relationship existing between S_1-S_2. When S_1-S_2 similarity is constant at identity and the degree of R_1-R_2 similarity is varied, positive transfer will initially decrease (A-B to A-B') leading to increasing negative transfer when R_1-R_2 is neutral (A-B' to A-C).

Component process theory assumes that associative learning is bidirectional in nature. Practice on A-B results in the development of A-B and B-A associations, both of which can provide significant sources of transfer. The B surface depends on the similarity between R_1-R_2. Hence A-B, A-C and A-B, C-D paradigms cannot involve transfer of backward associations (BA) because completely new responses characterize the transfer task. Transfer will be positive for the A-B, A-B position since BA learning facilitates the transfer task. When stimuli are at identity and response similarity decreases, positive transfer decreases to zero since the responses in the transfer task are dissimilar from those learned during the first list. This minimizes the possibility of B eliciting A.

When R_1-R_2 relations are at identity, varying the degree of S_1-S_2 similarity (A-B to C-B) results initially in decreasing positive transfer from A-B to A'-B and subsequent increasing negative transfer with increasing S_1-S_2 dissimilarity (A'-B to C-B).

Martin carried his analysis one step further indicating that secondary variables such as meaningfulness (m) or degree of list one learning (DOL_1) will influence the amount of total transfer that results from these varying components. Martin's component process theory thus makes the following specific predictions regarding net transfer effects:

Predicted Net Transfer Effects

	Transfer Component			Net Effect
Paradigm	R	F	B	
A-B	+	+	+	+ only
C-B	+	0	-	varies + to -
A-C	0	-	0	- only
C-D	0	0	0	0

The basic advantage of Martin's model is a refinement of predictions which take into account secondary variables. It should be noted, however, that three components do not, of course, exhaust all the courses of specific transfer that can be postulated on theoretical grounds. Martin's theory, for example, failed to identify stimulus and list differentiation components.

<u>A Generalization Surface for the Simultaneous Variation of Stimulus and Response Similarity</u>:

Underwood (1949) postulated the phenomena of Stimulus and Response generalization as the mechanism underlying observed transfer. Underwood (1966) proposed that the probability of stimulus generalization (PA') x the probability of response generalization (PB') = the probability of simultaneous generalization (G). Shea's (1969) experiment tested the prediction for the probability of simultaneous generalization. She had three levels of stimulus and response similarity. Stage 2 defined nine paradigms: A-B, A-B', A-B", A'-B, A"-B, A'-B', A'-B", and A"-B". A' words were highly similar to A words, while A" words were slightly similar to A words. A'-B', A'-B", A"-B', A"-B" all involve simultaneous generalization and were thus used to assess Underwood's model.

A multiple-choice (MC) task was employed to test for transfer on stage 2. All Ss received all paradigms. For example, if first list A-B pairs were Angry-Little, then the stage 2 multiple-choice item for A'-B' would be Enraged-(1) Neutral (2) Petite (3) Heavy. The Ss were required to recognize which of the three alternatives was similar to the first list response, Little. Experiment II employed an identical procedure with new stimulus and response materials.

The results revealed a strong effect for St and R dissimilarity. The effect of St dissimilarity is revealed to be greater than the effect of R dissimilarity. Such assymetry between St and R dissimilarity was not predicted. Two predictions were confirmed: (1)It is clear that Ss exhibited transfer of first list associations to a second task involving simultaneous generalization of new St and R terms. It should be noted that this transfer occurred without any stage 2 learning trials, i.e., no feedback was given during the MC test. (2)Increasing St and R dissimilarity did reduce the level of performance on stage 2.

Underwood's model PA' x PB' = G was examined by using the observed relative frequencies of choice for the A-B', A-B", A'-B and A"-B paradigms to predict relative frequencies for A'-B', A'-B", A"-B', A"-B" paradigms. X^2 analysis revealed that the differences between predicted and observed frequencies were non-significant except for A'-B" in the first experiment.

The assymetry between the St and R dissimilarity was not predicted. Shea reasoned that it may be the testing procedure itself that produces the observed difference. Response identification was measured by a recognition task and stimulus identification by recall of the first list. Hence, the greater difficulty of selecting the similar item on the St side would be reflected in a greater performance decrement for adjectives of increasing dissimilarity. The MC was replaced by a free recall task in experiment II. Here both St and R identification was measured via recall of the first list. Under this condition, the observed St and R dissimilarity gradients were symmetrical.

Shea used a single MC transfer test. Uehling and Underwood (1972) argued that there is not evidence for transfer effects over trials on a second list. Shea's single trial transfer task evidence doesn't readily allow specification of a set of laws relating similarity and transfer. Uehling and Underwood (1972) carried out three experiments: In Experiment I St similarity was varied (SV), but the response members were identical; in Experiment II, response similarity was varied (RV), with St terms identical; and in Experiment III similarity between both stimuli and responses were varied simultaneously (SV-RV). Three degrees of similarity were employed within each experiment.

Results indicated that in early transfer, when stimuli are varied and responses are identical, negative transfer is obtained. Dissimilar stimuli (A-B, C-B) yield high positive transfer with highly similar responses (A-B, A'-B). Dissimilar responses (A-B, A-C) yield negative transfer which decreases with increasing R similarity until zero transfer is obtained (A-B, A-B'). By varying simultaneously both stimuli and responses, zero transfer results. These findings are not in accord with Wimer (1964) and Shea (1969), who found some positive transfer with increasing similarity of both stimuli and responses.

Backward Surface

Osgood's transfer surface attempts to relate direction and degree of transfer to S_1-S_2 similarity and R_1-R_2 similarity. Houston (1964) attempted to describe similarity between first list stimuli and second list responses (S_1-R_2) and the similarity between second list stimuli and first list responses (S_2-R_1). Houston relabeled the dimensions of Osgood's transfer surface such that they refer to S_1-R_2 and S_2-R_1 similarity rather than to S_1-S_2 and R_1-R_2 similarity. This backward transfer surface generated four basic paradigms: C-D, C-A, B-C and B-A. The following four predictions were made:

(1)If the first list responses are neutral with second list stimuli (S_2-R_1 axis, i.e., A-B, C-A and A-B, C-D), then regardless of the degree of S_1-R_2 similarity, transfer will be minimal. In other words, when C-D is varied to C-A, no differential transfer is predicted. Thus a prediction for the C-A paradigm is equivalent to Osgood's C-B paradigm prediction.

(2)If the second list responses are neutral to the first list stimuli (S_1-R_2 axis, i.e., A-B, C-D paradigm), then as S_2-R_1 similarity increases, negative transfer will increase. Thus, when C-D varied to B-C, increasing negative transfer is predicted. The prediction for a B-C paradigm is equivalent to Osgood's prediction of an A-C paradigm.

(3)When stimuli of the first lists are identical to responses of the second list (S_1-R_2 axis, i.e., A-B, C-A paradigm), then as S_2-R_1 similarity increases, positive transfer increases. When C-A is varied to B-A, maximum positive transfer is predicted. This paradigm prediction is equivalent to the A-B, A-B paradigm prediction of Osgood's transfer surface.

(4)If the stimuli of list two are identical to the responses of list one (S_2-R_1 axis, i.e., A-B, B-C paradigm), then as S_1-R_2 similarity increases (A-B, B-A), transfer increases from negative to positive. In other words, maximum negative transfer is obtained for B-C which varies to maximum positive transfer for a B-A paradigm.

Houston reported that Murdock (1956) found positive transfer in a B-A paradigm while Murdock (1958) found negative transfer in a B-C paradigm.

Houston (1966) designed a study to generate the surface by testing three degrees of S_1-R_2 and three degrees of S_2-R_1 similarity. The following nine paradigms were examined: A-B, B-A, B'-A, C-A, B-A', B'-A', C-A', B-C, B'-C, and C-D. All lists were constructed of eight adjective choices from Hagen's (1949) lists. The results were in substantial agreement with the predictions made by Houston (1964). There was a significant S_1-R_2 effect with increasing S_1-R_2 similarity leading to better second list performance.

S_2-R_1 main effect was not significant. However, as predicted, the interaction between S_1-R_2 and S_2-R_1 similarity was significant. Compared to control group C-D, performance in B-A and B'-A paradigms was slightly better while performance in the B-C paradigm was significantly poorer. B'-C did not differ significantly from control but its means were in the predicted direction. As predicted for paradigms, C-A, C-A', B-A' and B'-A', zero net transfer was obtained.

According to Houston, the predicted transfer should shift from positive to negative as similarity of S_1-R_2 decreases. Houston (1966b) tested this prediction by varying six degrees of S_1-R_2 similarity. He used common adjectives from Hagen (1949). The results showed that there is clearly a decline in performance as the similarity between S_1-R_2 decreases.

Component Mechanism in S_1-R_2 and S_2-R_1 Paradigm

We have seen so far that Martin's component process offers better predictions than Osgood's forward transfer paradigm surface. It would seem desirable, therefore, to attempt a description of the component mechanisms in S_1-R_2 and S_2-R_1 paradigms. This approach would thus allow precise predictions in terms of secondary variable interactions in backward transfer paradigms.

Knight (1973) adopted a component process approach to the analysis of S_1-R_2 and S_2-R_1 transfer. The analysis of S_1-R_2 and S_2-R_1 transfer demands the assumption that PA acquisition consist of stimulus differentiation, response learning and associative learning. Like Martin's component process, this analysis also makes assumptions of associative symmetry. Thus the following four separate transfer components are assumed: (1) Stimulus differentiation (St component), (2)Response learning (R component), (3)Forward associative learning (F component), (4)Backward associative learning (B component).

The St component is defined as the effects of first list stimulus differentiation on second list response learning (S_1-R_2).

The R component is defined as the effects of first list response learning on second list stimulus differentiation (S_2-R_1).

The F component is defined as the effects of first list forward associative learning on the development of second list backward associations.

The B component is defined as the effects of first list backward associative learning on the development of second list forward associations.

The A-B, B-A paradigm involves possible effects from all four components. The St component has a facilitative effect on the C-A paradigms. Interference is expected from the F component. In the same way, the R component has a facilitative effect on the B-C paradigm but interference is predicted from the B component.

The major thesis of this model is that what is transferred is some combination of these four effects. Four separate transfer surfaces, one for each defined component, are presented. The following predictions were made from each surface:

According to the St component surface:

(1)When stimuli of list one are identical to responses of list two (S_1-R_2 axis), the transfer will be positive and maximal regardless of the degree of S_2-R_1 similarity. Thus, transfer will be positive in B-A and C-A paradigms.

(2)As S_1-R_2 similarity decreases from identity to neutrality, positive transfer decreases and reaches zero when S_1-R_2 are neutral (i.e., B-A varied to B-C and C-A varied to C-D). It should be noted that in this surface, degree of S_2-R_1 similarity is not affected by any transfer effect and the St component makes no prediction of negative transfer.

According to the R surface:

(1)When stimuli of the second list are identical to responses of the first list (S_2-R_1 axis), the transfer will be positive and maximum for B-A and B-C paradigms, regardless of degree of S_1-R_2 similarity.

(2)As similarity between S_2-R_1 decreases, positive transfer decreases to zero when B-A is varied to C-A and B-C is varied to C-D.

It should be noted that in this surface, degree of S_1-R_2 similarity does not cause any transfer effect, and the R component makes no prediction for negative transfer.

According to the F component surface:

(1)The effect is maximally positive with S_1-R_2 and S_2-R_1 identity in a B-A paradigm.

(2)When similarity is decreased from identity to neutrality in S_1-R_2, keeping identity constant at S_2-R_1 results in decreasing positive transfer as B-A varies to B-C.

(3)When similarity is decreased from identity to neutrality in S_2-R_1, keeping S_1-R_2 at identity results in maximal negative transfer when B-A varies to C-A.

(4)When similarity between S_1-R_2 is varied from identity to neutrality and S_2-R_1 is kept neutral, decreasing negative transfer is obtained. Thus when C-A is varied to C-D, zero transfer is predicted.

(5)When S_1 are identical to R_2, varying similarity in S_2-R_1 from identity to neutrality results in a decrease from maximal positive transfer (B-A) to maximal negative transfer (C-A).

According to the B component surface:

(1)Maximal positive transfer results when both S_1-R_2 and S_2-R_1 are at identity (B-A paradigm).

(2)When S_1-R_2 are still at identity but degree of similarity is decreased from identity to neutrality, decreases in positive transfer will be obtained (B-A varied to C-A).

(3)When S_2-R_1 are at identity but S_1-R_2 are varied from identity to neutrality, maximal negative transfer is predicted when B-A is varied to B-C.

(4)When similarity between S_2-R_1 decreases, negative transfer decreases until S_2-R_1 is neutral (B-C varied C-D).

(5)When S_2-R_1 are at identity and degree of similarity varies from identity (B-A) to neutrality (B-C) in S_1-R_2, positive to negative transfer is predicted.

Mechanism of Transfer in S_1-S_2 and R_1-R_2 Paradigm

When experimental paradigms of transfer are compared with control paradigms, the observed differences in performance represent the combined effects of several components. Martin's component process approach has drawn attention to differentiating response and associative stages in PA acquisition. A study by Postman and Stark (1969) focuses on the assessment of the component of response availability. To assess the role of response availability, a comparison was made between the transfer effects obtained under two conditions of practice: recall method (R) and multiple-choice method (MC). In R method, loss of recall reflects both associative unlearning and response availability, while loss of recall in MC method reflects only associative unlearning. The two methods of practice were compared for C-D, C-B, A-Br, A-B', and A-C transfer paradigms. In addition, a single-list control was employed. It was reasoned that response availability is a positive factor in C-B and A-Br paradigms and there should therefore be a shift in the direction of greater negative transfer, when there is a change from R to MC method. The results support Osgood's net transfer surface with A-B' being slightly positive; A-C and A-Br negative; and C-B zero relative to C-D when the recall method was used. All paradigms were negative relative to C-D when the MC method was used. The differences between condition R and MC in list 2 learning provide clear evidence for the systematic effects of response availability on transfer.

A-C Transfer

This paradigm has traditionally been classified as one of associative inhibition. Muller and Schumann's (19894) law of associative inhibition on an A-B, A-C paradigm was confirmed by subsequent investigations which indicated that learning of new responses to old stimuli leads to negative transfer. According to both Osgood (1969) and Martin (1963), forward association is the source of interference in this paradigm. As Kausler pointed out, a potent mechanism in this paradigm is that of response interference (i.e., the competition existing between B and C response to A stimuli during practice on the A-C pairs of list 2). This competition inhibits performance on list 2, which contributes a large source of negative transfer in an A-C paradigm. The question is that after learning A-B associations, whether B responses to the A stimuli are simply displaced by C responses and remain available for recall on demand or are the B responses extinguished following practice on A-C pairs.

Two theoretical approaches have been used to answer this dilemma. According to the theory of reproductive inhibition proposed by McGeoch (1942), the availability of the original association is not reduced by interpolated learning. The old system of responses remains intact while the new one is acquired. This assumption has been designated the independent hypothesis (Barnes & Underwood, 1959). According to the independent hypothesis, negative transfer results from loss of differentiation between two list responses which causes competition between alternative responses. This inhibits recall.

A different approach has been taken by the two-factor theory of Melton and Irwin (1940). They proposed two factors to account for Retroactive inhibition (RI): (1)Unlearning of originally learned (OL) responses as a consequence of interpolated learning (IL) and (2)competition between OL and IL responses at the time of OL recall. The theory differs from McGeoch's theory in that list 1 associations are unlearned or extinguished during the learning of the second list. In an extensive review of RI and PI, Keppel (1968) stated that although the mechanism by which unlearning is produced is not clear, its role in RI is undeniable. According to Barnes and Underwood (1959) this assumption has been designated as an unlearning or extinction hypothesis.

Barnes and Underwood (1959) carried out an experiment to test the independent hypothesis and extinction or the unlearning hypothesis. In their study, different groups of Ss were stopped at various points in learning list 2 and were asked to give both list 1 and list 2 responses to each stimulus. If, as the degree of list 2 learning increase, there is an increasing inability to give list 1 responses, the extinction hypothesis would be favored. If there is no such loss, then the independent hypothesis would be favored. Experiment I used an A-B, A-C paradigm. All Ss learned the first PA list (list 1) of eight pairs to one perfect trial, then list 2 was presented for 1, 5, 10 or 20 anticipation trials for the four groups in each experiment. After the specified number of trials, the memory drum was stopped. Eight nonsense syllables of 60% to 73% association value were used as stimuli for all lists. Responses were two-syllable adjectives taken from Hagen (1949). It should be noted that as the number of learning trials on list 2 increased, the number of correct responses given from this list increased. Responses from the first or A-B list showed a gradual decline as the number of trials on list 2 increased. The data indicated that the A-B associations were extinguished. Recall of list 1 associations decreased progressively throughout the learning of A-C with nearly 50% loss after 20 trials on A-C. The data seem to support the extinction hypothesis, which however, does not indicate why all the items are not extinguished or what the mechanism underlying retention of 50% of the A-B associations are. It seems reasonable to reject the independent hypothesis since this hypothesis fails to explain loss of A-B associations over and above normal forgetting.

Jung (1970) argued that Barnes and Underwood's (1959) study showed strong support for the unlearning or extinction hypothesis, but it is not clear whether such unlearning is a prerèquisite for A-C learning or merely a by-product of A-C learning. To test these phenomena, two groups were trained on the first list until Ss correctly anticipated six of the nine pairs on a given trial. Then the second list was presented for six trials in single alternation with six trials of the reinstated first list. Stimuli were nonsense syllables and responses were two-syllable adjectives. The results showed typical negative transfer. The A-C condition had a mean of 10.2 correct responses as compared to 24.7 for the C-D group ($F = 12.4$, $p<.01$). There was, however, no significant difference in the six reinstated first list trials with mean correct responses of 33.5 for A-C and 36.0 for C-D. Hence, A-B unlearning is not a necessary condition for learning an A-C list. Jung concluded that differentiation of list membership of items may occur as the reinstatement period continues, thus making it possible to learn and distinguish both lists without unlearning the previous list on alternate trials.

It should be noted that Jung used a mechanism of list differentiation to (Thune and Underwood, 1943) explain how alternating lists can be learned without continually unlearning one list in order to learn the other. The data do, however, support independent hypothesis since data did show that alternating trials provide two independent response systems. It can also be argued that perhaps list one was relatively overlearned (6/9 CR) and that introducing the second list prevented receiving interference from the reinstatement procedure.

Crouse (1968) carried out a similar study, but in this experiment <u>S</u>s did not learn list one to a set criteria. Crouse introduced alternation of training on two lists from the start of the session. He used five different paradigms: C-D, C-B, A-C, A-Br, and A-B'. Stimuli were low frequency three-letter words from Thorndike-Lorge (1944). Responses were adjectives taken from Hagen (1949). High <u>m</u> items were used to minimize response learning. Twenty trials were given on each list in the alternating two-trial fashion.

Regarding A-B list acquisition, both A-C and A-Br paradigms were significantly inferior to C-D which did not differ from A-B' or C-B. This supports Osgood's transfer surface. The same results are shown for these paradigms in McGovern (1964) and Martin (1965). The interesting thing about Crouse's data is that they provide an independent estimate of FAI in A-C and A-Br paradigms. The mean difference in terms of correct responses between C-D and A-C was 27.0 while the mean difference between C-B and A-Br was 25.35. It should be noted that there is a positive component of stimulus differentiation in A-C plus a negative component of FA. There is a positive component of stimulus differentiation in an A-Br paradigm and, in addition, forward and backward associative interference. Thus, after subtracting out backward associations from a C-B paradigm, only forward associative components are derived. Using mean differences (C-D vs. A-C 27.00 and C-B vs. A-Br 25.35), A-C and A-Br paradigms yield equal FAI. In a like manner, estimates of BAI can be derived for both C-B and A-Br paradigms. By taking mean differences between C-D and C-B (18.15) only backward associative interference remains, while taking mean difference between A-C and A-Br (16.50) forward association cancels out and only BAI remains. Thus, BA are equal in C-B and A-Br paradigms. Whether BAI and

FAI are equal can be checked by adding both FA (C-B and A-Br 25.35) and BA (C-B and A-Br 16.50) which sum up to 41.85, which is very close to the mean difference taken from C-D vs. A-Br (43.50). To summarize: (1) FAI in A-C is approximately equal to that observed in A-Br; (2) BAI found in a C-B paradigm is approximately equal to that observed in an A-Br; (3) Strength of FAI in A-C appears to be greater (27.0) than BAI observed in either C-B (18.15) or A-Br (16.50) paradigm.

The same phenomenon of associative symmetry has been attacked by Goulet and Behar (1966). They argued that if the strength of S-R and R-S associations (i.e., FA & BA) are equated at the end of list 1 practice, equal negative transfer effects would be expected for A-B, A-C and A-B, C-B paradigms (if RL were minimized). This was accomplished by asking Ss to learn list 1 bidirectionally or unidirectionally. The unidirectional lists involved conventional PA learning whereas the bidirectional task involved the anticipation of both A-B and B-A on list 1. The bidirectional task was used to equate strengths of A-B and B-A associations at the end of list 1 practice. Under these conditions, greater negative transfer would be expected in a C-B paradigm after bidirectional practice on list 1 (relative to unidirectional practice). With A-C, the negative transfer effect should be independent of the type of list 1 practice in that A-B associative strength is not changed after bidirectional practice. The PA lists consisted of eight two-syllable adjective pairs (Hagen, 1949). List 2 was mixed, i.e., 4 A-C and 4 C-D pairs. For bidirectional lists, half of the pairs were A-B and half were B-A in each order. List 1 was learned for two successive errorless trials. After 10 trials on list two, an MFR test was given. For C-B groups, B-A recall was tested, while for A-C groups, A-B recall was tested. The mean % of transfer was:

Unidirectional learning:	-34.74 for A-C -13.49 for C-B
Bidirectional learning:	-15.26 for A-C -27.51 for C-B

The statistical analysis yielded a significant direction by paradigm interaction. The interaction reflected greater negative transfer after bidirectional for A-B with an opposite tendency for an A-C paradigm. The recall data showed recall increased with bidirection for a C-Bparadigm. The mean recall for unidirection was 1.44 while the bidirectional mean recall was 3.12. For the A-C paradigm, recall was approximately the same for unidirectional (3.19) and bidirectional (3.12) learning.

The data indicate that (1) the negative transfer effect in C-B is attributable to competition between list 1 and list 2 (R-S) associations and (2) the magnitude of negative transfer in C-B is a function of the strength of list 1 R-S associations.

The reduction in magnitude of negative transfer in bidirectional learning of the A-C paradigm was not predicted by the authors. It is possible that B-A practice reduced the strength of A-B associations. This conclusion was not supported by recall since bidirectional learning did not affect A-B recall.

Stetten (1970) replicated the Goulet and Behar experiment and he reported that magnitude of negative transfer increased following bidirectional practice for C-B Ss, however, the reduction in amount of negative transfer for A-C was not observed.

St Differentiation

Martin's component process model does not take into account stimulus differentiation as a component. In his theory the A-C paradigm yields negative transfer effects only from forward associative components. Since stimulus members are the same in both lists, in an A-B, A-C paradigm, as opposed to an A-B, C-D paradigm, one would expect a greater positive component. Underwood and Ekstrand (1968) carried out an experiment to test transfer of stimulus differentiation from one list of pairs to another.

In an A-B, A-C paradigm it is presumed that in learning A-B, differentiation among stimuli must necessarily be established. If the differentiating of representational responses acquired in A-B is immediately evoked upon the presentation of A-C, a positive factor should be introduced into the transfer performance as compared with the usual control paradigm, A-B, C-D. Since the control paradigm has different sets of stimuli in the two lists, no transfer of stimulus differentiation is possible and differentiation among stimuli of C-D must be established as a part of overall learning.

If the interstimulus similarity is low among A terms, differentiation should be easy and, therefore, only a small positive component is transferred to the second list. If, however, interstimulus similarity is very high, a great deal of learning time is required to establish differentiation among stimuli in the A-B list. Hence, a large positive component should be transferred in learning the second list as compared with C-D in which S must establish differentiation among the highly similar C terms without benefit of prior differentiation. This makes clear the prediction that one would expect an interaction between paradigm and similarity for second list performance. With low interstimulus similarity, the ususal negative transfer is expected--C-D performance will be better than A-C performance. With high interstimulus similarity, the transfer of stimulus differentiation should add a large positive somponent to A-C performance and therefore performance in A-C learning will be superior to that of C-D. Underwood and Ekstrand carried out a series of three experiments: Experiment I had one perfect trial in list 1 learning. Experiment II used a criterion of 3 successive perfect trials. In Experiment III they used completely new list materials. In all experiments list 2 was presented for 10 trials. They used 6 pairs in which stimuli were consonant syllables and common three-letter words were used as response terms. For low similarity (LS), 18 different consonants were used. For high similarity (HS), only five different consonants were used.

The results showed that HS lists were difficult to learn (mean trial to criterion 33.52) compared to LS list (mean trial to criterion 11.29). Two transfer measures were used for the second list, namely number of correct responses on the first two trials and total correct responses across ten trials. The expected interaction was present but its magnitude was very small. Paradigm x similarity interaction was significant on the first two trials only in experiment III. If transfer of differentiation occurs, error rates should be decreased. This did not happen. For all experiments the error rates on the transfer list were higher for LS. It should be noted that learning performance in the first list was different for HS (TC 33.52) and LS (11.29). Underwood et al. concluded that the data generally indicated that transfer of St differentiation, established in A-B learning is so slight that the Ss essentially must "start all over again" in learning A-C. Underwood and Freund (1968) carried out another experiment to test this hypothesis. They reasoned that response terms may in some manner be used to discriminate the stimulus terms. The experiment used A-B, A-C and A-B, C-D paradigms and only high formal St-similarity. In one treatment Ss learned A stimulus terms by a free recall (FL) procedure prior to learning A-B. In this treatment it was assumed that FL must result in the establishment of differential cues of some kind for each trigram. When Ss learned the A-C list, they would continue to use these differential cues to differentiate the stimuli. Therefore, transfer of the differentiation to A-C should result in better performance. The other treatment consisted of requiring Ss to learn A-B pairs by FL under the assumption that this would encourage the use of response terms to discriminate stimulus terms. Therefore, no transfer of St discrimination from A-B to A-C should be found. Six trigrams were used as the A terms while R terms were common three-letter words. Half of the Ss were given only trigrams to learn (condition T) and half were given the trigram-word pairs to learn (condition TW) for 15 alternate study and test trials. List 1 was learned for three successive perfect trials while list 2 was presented for 10 anticipation trials.

The most apparent effect was superiority of group A-C (T) over the other groups. Compared to C-D (T), very high positive transfer was found. There was little difference between C-D and A-C when TW training was given. Thus trigrams alone allow Ss to establish differentiating cues among them; whereas training on the pairs increases the likelihood that Ss will use response terms to discriminate stimulus terms. Experiment II replicated Experiment I except a new set of trigrams was used. The results were somewhat less clear than those for Experiment I. The basic findings remain the same. The results of both experiments were consistent with the hypothesis that with high formal similarity among St terms and with common words as responses, Ss may differentiate the stimulus terms via the R terms.

Underwood and Freund tested the same hypothesis by using a different approach in Experiment III. If two of more stimuli are paired with the same R term in A-B learning, the R term will be prevented from functioning as a discriminative cue. The first list had either 2, 3, 4, 5, or 6 different response terms. As the number of different responses increases, performance increases in both paradigms. The complete lack of difference in transfer between A-C and C-D lists showed lack of any evidence for transfer of St discrimination.

Saravo and Price (1967) carried out similar studies with sixth grade students. They varied three degrees of stimulus similarity in A-C, A-Br and C-D paradigms. St members of high similarity shared two letters in common (e.g., NAL, JAL), those of medium similarity had one letter in common (DEK, MES) and those of low similarity shared no elements (WID, ROG). Rs were of low similarity. The two lists had six pairs each. The mean number of trials to criteria for low, medium and high was 13.6, 15.0 and 15.9 respectively. Negative transfer for the A-C and A-Br paradigms increased as St similarity increased. The main effect for similarity was nonsignificant. However, the common letters defining any level of similarity always appeared in the same position in each of the syllables and it is possible that the effects of similarity were attenuated through reliance solely on the letters which differed among the stimuli. Secondly, there were no observed differences between similarity conditions on first list performance as would be expected in view of Underwood and Ekstrand's results.

Kenelly (1970) argued that Underwood and Ekstrand's results are due to factors other than St differentiation. In an A-B, A-C paradigm the severity of associative interference during A-C learning is determined by the amount of first list associative learning. In Underwood and Ekstrand's study, the strength of first list associations should have been greater at the end of first list learning under LS (easy material) than under HS (difficult material). Kenelly argued that if a positive stimulus differentiation component is transferred to the second list then this effect should be predominant during the associative learning stage of A-C. It is possible that St differentiation has its effect later during the associative stage of second list learning and is contaminated with RL.

Each list consisted of 7 pairs. St terms were 3-letter consonant syllables and R terms were m dissyllables selected from Noble. One measure of the response learning stage and two measures of the associative learning stage of A-C learning were analyzed. The R learning stage took significantly longer under HS than LS conditions. Associative error scores showed more associative errors occurred under HS than under LS. The interaction between paradigm and similarity was significant. A-C produced fewer errors (26.65) than did the C-D paradigm (46.50) under conditions of HS but not under conditions of LS. This was also supported by intralist response intrusions where A-C conditions gave significantly less intrusions under A-C (9.75) compared to C-D (17.70) in HS condition. C-D gave less intrusions (5.80) compared to A-C (7.25) under LS. Both measures of the associative learning stage provided strong evidence that transfer of St differentiation does occur in the A-C paradigm.

Mull and Richman (1973) manipulated stimulus difficulty by using unfamiliar verbal materials as stimuli. They reasoned that when unfamiliar nonverbal materials are used as stimulus units, negative transfer from the first to the second list is significantly reduced, i.e., in an A-C paradigm when unfamiliar stimuli are used, a large positive component is transferred and should transfer to List 2 and counteract the negative effects of associative interference. Group V (verbal) had 2-syllable adjectives as stimuli while group N had nonsense figures. Ss were trained with unfamiliar nonsense figures as stimuli to test the hypothesis that positive effects of St learning transfer from the first to the second list resulting in a reduction of negative transfer. Both groups learned A-B, A-C and A-B, C-D paradigms. Group V learned 8 common 2-syllable adjectives. Responses for both groups were CVC nonsyllables. The results showed that C-D took significantly fewer trials to reach criterion than A-C when stimuli were 2-syllable adjectives, thereby demonstrating negative transfer effects with verbal stimuli. The opposite findings were evidence in group N where C-D took a significantly greater number of trials than A-C. Thus when nonsense figures were used as stimuli, positive transfer effects resulted from the A-C paradigm. Utilizing nonsense figures as stimuli, Ellis (1968) found positive transfer effects in an A-C paradigm when words were employed as R terms, but failed to find the effect when 0% association value CVC were used. In Mull and Richman's study, positive transfer effects were obtained with 100% association value CVC R terms. Hence as R meaningfulness decreases, the amount required for RL increases and stimulus differentiation effects decrease. It would be interesting to carry out an experiment using complex stimuli with high and low R meaningfulness.

In general there is good support for St differentiation. When St differentiation is difficult, it becomes a significant component for transfer and it facilitates A-C relative to C-D acquisition where new and difficult stimuli must be differentiated. Such strong support for stimulus differentiation as a positive component in a A-C paradigm indicates a limitation of Martin's component theory in not including stimulus differentiation as a positive component in A-C and A-B' paradigms.

C-B Transfer

According to Osgood's net transfer surface, C-B transfer paradigms yield zero transfer compared to nonspecific control groups. According to Martin's component analysis, a C-B paradigm would have a positive component from response learning, but a negative component from backward associative learning and, therefore, transfer effects will vary from positive to negative. Secondly, the direction and degree of transfer in a C-B paradigm will also interact with secondary variables.

Early research has indicated that C-B learning was largely positive relative to C-D (Bruce, 1933; Hamilton, 1943; and Wylie, 1919). This was supported by more recent investigators, e.g., Dean & Kausler (1964), Mandler & Heineman (1956), and Meikle (1968). Other studies, Dallett (1962), Goulet & Behar (1966), Kausler & Kanoti (1963), Postman (1962), Twedt & Underwood (1959) have reported significant negative transfer effects. Martin's component process reconciles these conflicting results by interaction of secondary variables.

Goulet and Crouse have offered strong support for the notion of BAI in a C-B paradigm. Giving bidirectional learning, Goulet & Behar obtained increased amounts of negative transfer when RL was minimized by using high m responses. Recall data showed that significant recall was increased in B-A recall on MFR task. In Crouse's experiment alternating A-B and C-B practice every two trials resulted in BAI which was equal to that observed in an A-Br paradigm.

Johnston's (1968) research dealt with the role of associative bidirectional interference in a C-B paradigm. He used C-B and C-D paradigms and two levels of relearning (RL) direction (A-B and B-A). He presented PL and IL for 15 trials and RL was presented for only two trials. Ss were given a matching task with either B or A items presented as stimuli and were required to supply the appropriate items selected from either B or A terms.

The results on prior learning showed no significant effect. Four groups were comparable in terms of original A-B learning. Weak negative transfer effects were revealed during the last half of IL in the C-B paradigm compared to the C-D paradigm. The trial by paradigm interaction was significant. Analyses of types of errors were done to shed more light on the component process model. It was assumed that omission errors and misplacement errors are errors of RL and AL respectively. It should be noted that omissions decreased as trials increased and misplacements increased as learning progressed. These data support the Underwood _et al._ two-stage analysis that as learning proceeds, performance becomes less a function of RL and more a function of AL. The positive transfer of RL in C-B and negative transfer in AL supports Martin's model. It also accounts for the initial difference between the two paradigms in terms of number of correct responses. Relearning data provided further support for the component process model since recall of both A-B and B-A was inhibited in C-B relative to C-D. This gives further evidence that B-A is formed during A-B learning.

Due to the weak negative transfer effect in Experiment I it was reasoned that when demands on RL are minimized only BAI should account for direction and degree of transfer and hence, greater negative transfer would be expected in a C-B paradigm. The transfer list was a forced-choice matching task. The appropriate responses were typed and _S_s were required to select a response for each transfer stimulus. By using a multiple choice task the response is available to _S_s and hence the advantage of RL in a C-B paradigm compared to C-D paradigm is minimized. The mean number of trials to criterion was significantly greater in C-B (5.90) than C-D paradigm (3.45). The C-B paradigm produced negative transfer of associative learning and this transfer effect is most apparent when RL requirements are minimal.

Contribution of RL in a C-B paradigm has also been demonstrated by varying response meaningfulness. With Hm responses negative transfer is usually observed since responses are learned more rapidly and a greater amount of AL occurs (Dallett, 1962; Goulet & Behar, 1955; Jung, 1963; Kausler & Kanoti, 1963; and Twedt & Underwood, 1959). With low m responses, positive transfer is observed because greater amounts of time are required to learn the responses. C-B subjects have the advantage of this learning in the second list compared to C-D Ss who must learn new difficult response terms (Dean & Kausler, 1964; Jung, 1963; and Mandler & Heineman, 1968).

Twedt and Underwood (1959) argued that the mechanism by which list 1 backward associations might interfere with list 2 learning may possibly be that when C is presented as a stimulus, subjects think of B which via backward association makes Ss think of A (St of first list). This can cause the subject to reject C as the appropriate stimulus for the response item B. Thus Ss reject B as a result of (a) elicitation of a list-1 backward association (b) a breakdown of list differentiation from list 1 A stimulus to list 2 C stimulus. This stimulus differentiation hypothesis predicts that the easier it is to identify a St as a list member, the less should be the amount of negative transfer in a C-B paradigm. Schwartz (1968) manipulated St differentiability by using either the same class of stimulus materials in two lists (low differentiability) or different classes of stimulus materials in two lists (high differentiability). Results failed to support the prodiction that transfer in C-B should be less negative with high differentiability. These results were considered inconclusive as a test of hypothesis since overall transfer was slight.

Results of an investigation carried out by Olivier and Kausler (1966) do support Twedt and Underwood's hypothesis. They argued that negative transfer in C-B should be less when stimulus components of the first list and the second list are from different form classes. The experimental procedure involved 3 experimental and one control group. All four groups had the same second list consisting of nonsense syllables as stimuli and adjectives as responses. E1 group stimuli of list 1 were the same as list 2 nonsense syllables. E1 St were adjectives and E3 stimuli were geometric figures. All nonsense syllables were of high (80-100%) associative value (Archer, 1960). Results were as expected. Negative transfer was evident in all 3 groups and the degree of transfer was greater under E1 (same class stimuli). Groups C, E2 and E3 being equal suggests that the effects of BAI would seem to dissipate somewhat when stimuli of the first and second lists represent different form classes.

<u>Summary</u>

The Goulet and Behar and Crouse and Johnston experiments showed that associative interference is bidirectional. Whenever response learning is minimized, greater associative interference is obtained. Most experimental findings on the C-B paradigm support Martin's component process model rather than Osgood's net transfer surface. The direction and magnitude of transfer in the C-B paradigm interact with DOL_1 and response $\underline{m}$, but shall be further discussed as a secondary variable topic. Support for the Twedt and Underwood (1959) stimulus differentiation hypothesis is not conclusive.

The effect of the response learning component has not been fully investigated. Martin's component process predicts a high degree of positive transfer when response learning is enhanced and associative interference is minimized. Such a prediction, however, has not been experimentally tested.

As Knight (1973) concluded, BA develops during first list acquisition, transfers negatively, and interferes with C-B learning. However, the focus of the BAI effect remains elusive.

<u>A-B' Transfer</u>

In an A-B' paradigm B' indicates that the responses of list 2 are related in some manner to those of list 1. On the transfer surface this relation is expressed in terms of the response similarity dimension. Osgood's transfer surface predicts diminishing negative transfer as the responses of list 2 change from neutrality (A-C) to increasing degree of similarity. Some studies have found large prositive transfer effects (Bastian, 1961) while others (Dallett, 1962) have reported zero or slightly negative transfer. Bastian (1961) also discovered that positive transfer is greater when B and B' are related as word associates (e.g., table-chair) than when they are related by secondary similarity (e.g., happy-elated). Thus the similarity relation between B and B' has been varied by degree of semantic simialrity and degree of associative connection.

Bastian's (1961) experiment separated associative strength and similarity of meaning. List 2 responses were selected by three relationships. Type A elements were strong associates of list 1 response words and were judged to bear no similarity to them in meaning. Type S elements were very infrequent word associates of list 1 responses but were judged to be highly similar to them in meaning. Type C elements were control words which were neither associates nor judged to be similar in meaning. All analyses of second-list learning and first list recall and relearning clearly indicated that associative interlist recall is sufficient to produce verbal generalization. Slamecka (1967) found that the presence of semantic relationships between responses, either of synonymity or anonymity, resulted in clear cut positive transfer.

Inspection of items in Bastian's list of materials showed that in type A items, responses were still semantically related, not through similarity but through anonymity. Thus the problem of semantic vs. associative relation in transfer needs further elucidation.

D'amato and Rugger (1971) used an A-B' paradigm as A-Bs and A-BA. Items related in meaning to first list responses were used to make up the semantically related transfer lists (A-Bs), while items merely associatively related made up most of the associatively related transfer lists (A-BA). The results suggested that positive transfer in A-B' depends almost entirely on a semantic or synonymity relationship between B and B' and is not due to associative relationships between B and B'.

This is supported by Stark (1973). She used two types of associates in the A-B' paradigm: synonyms and nonsynonyms. To evaluate the R component and the associative component in an A-B' paradigm, recall and multiple choice methods of learning were used. There were 20 synonyms (S) and 20 non-synonyms (NS) items. NS items were words likely to come to mind when thinking of first list responses. The results showed that for both synonyms and non-synonyms there was initial positive transfer with a shift to negative transfer for NS group. For non-synonyms the shift from net positive to negative transfer indicated both positive and negative sub-components of associative learning, while the synonyms provided evidence of associative facilitation.

According to the component process analysis of A-B' learning, RL represents a positive component and associative learning consists of both interference and facilitations whicn vary as functions of similarity. It should be noted that for synonyms, the present study provides evidence for associative facilitation while the Postman-Stark (1969) study provides evidence for associative interference. The present author argues that in the later study responses were synonyms of unknown, but probably low associative strength. In contrast, in the present study second-list responses were primary associates of the first-list words.

Thus all of the above studies, either using associatively related similarity or meaningful similarity, found positive transfer in an A-B' paradigm. Historically, A-B' has been considered a positive transfer paradigm. Two theoretical approaches have been considered for a source of positive transfer in this paradigm.

Underwood (1957) proposed an accumulated mechanism of parasitic reinforcement for response similarity. According to this interpretation reinforced practice on A-B during first list learning not only strengthens the connection between A and B but also between A and a range of responses similar to B. These generalized associations A-B', A-B" receive parasitic reinforcement during acquisition of A-B.

An alternative interpretation for response similarity is mediation. It is possible that after acquisition of A-B, the associative chain, A-B-B', will permit the subject to make correct responses in the transfer stage. There are many experimenters who found support for a mediation hypothesis, e.g., Barnes and Underwood (1959), Jenkins, Foss and Odom (1965) and Slamecka (1967).

Recently, the mediation hypothesis has encountered a potentially serious difficulty. One reasonable assumption is that mediation takes time. Mediational effects should, therefore, increase as the anticipation interval is lengthened. That is, the more time the subject has to give, the greater the likelihood of mediational chain being successfully completed. This, however, failed to materialize in several experiments. Richardson

(1967a) proposed to test this hypothesis using three paradigms (A-B', A-C and C-D) with three different rates of anticipation interval (AI): .75:2, 1.5:2 or 3:2. The responses were either nouns or adjectives selected from Hagen (1949). All Ss were given free recall immediately after both first and second list learning. The results showed that anticipation interval had a significant effect. Mean trials to criterion were 16.03, 7.11 and 6.50 for .75, 1.50 and 3 seconds, AI groups respectively. However, paradigm and paradigm x AI failed to reach significance. Positive effects in an A-B' paradigm were observed only in early trials 1-5. Recall data showed no relationship between recall and AI. If .75 AI prohibited mediation then it might be expected that there would be some unlearning in an A-B' condition compared to other AIs. There was no loss in the A-B' condition with the .75 AI. The present results offer no support for the hypothesis that positive transfer is a function of the AI on the test list. Spear, Mikulka and Podd (1966) also failed to find differences between A-B', A-C and C-D conditions using either 4, 2 or 1 second AI.

Richardson's (1967b) Experiment II employed two rates of presentation: either 1:1 or 3:1 during transfer. He used the latter material in a transfer paradigm. The stimuli in the two lists were the same and the second list response was a letter two steps in the alphabet beyond the first-list response. Following first-list acquisition Ss were completely instructed regarding the nature of the transfer task. There was no positive transfer to the second list when it was presented with a 1 second AI and large positive transfer was found with 3 second AI. Thus results of the present study do support a mediation hypothesis.

It should be noted that this experiment differed from 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 (3) the Ss were instructed as to the nature of the transfer task. It is not known which factors produced the observed difference in the performance of the mediations Ss.

Richardson's (1968) Experiment III reconciled the above described methodological differences. He used antonyms and synonyms in the A-B, A-B' paradigm, varying two rates of AI in the second list: 1:1 and 3:1. He also used two sets of instructions: half of the Ss were given standard instructions following A-B acquisition while the other half were given specific instructions which informed them of the specific relation between the two lists. Analysis on correct response showed that a 3 second AI was significantly superior to a 1 second AI. The main effects of instructions was not significant. The List x AI and AI x instruction interactions were significant. The Instruction x AI interaction showed that specific instructions inhibit performance with 1 second AI and facilitate performance at 3 seconds AI, i.e., when sufficient time is not allowed, specific instructions inhibit performance. The interaction between AI x list indicated that increased AI had less effect on the C-D control condition than on the two positive transfer conditions. The interaction between AI and paradigm was also significant. Longer AI had a greater effect for A-B' Ss than for C-D Ss.

The results of Experiment III make it less plausible that instructions, materials, or the specific AIs were the responsible factors for the conflicting results. Richardson concluded that all the studies which have failed to find an interaction between AI and paradigm used a 2 second study interval except one experiment by Richardson and Brown (1966) which used either a 1 second or a 3 second study interval. Richardson proposed an alternative explanation, arguing that mediating responses occur when both stimulus and response items are contigous, i.e., during the study interval. If the study interval (1 second) does not permit the discovery of mediating responses in the control condition, then increases in AI facilitate the positive transfer condition more than the control condition. In other words, given a sufficiently long study interval, the control and experimental subjects have an opportunity to develop mediational links between stimuli and responses. Consequently both benefit from an increase in length of the study interval. However, when the study interval is short, mediators are much more available to experimental subjects who therefore derive greater advantage from increases in response intervals.

Richardson's hypothesis does not, however, explain the positive transfer effect obtained with response intervals that are presumably too short to allow any mediation to occur. In accounting for such findings, the hypothesis of parasitic reinforcement appears to have an advantage.

Summary

In general, both theoretical approaches have considerable empirical support. There are conflicting results obtained by making B' either semantically or associatively related. It is confusing since the use of effective mediators would be most readily predicted in those conditions where B is associatively related to B' rather than semantically related. This is not supported in the literature. Stark (1973) suggested that according to a component process analysis of A-B' learning, response learning yields a positive component while associative learning yields both interference and facilitation subcomponents which vary as a function of similarity.

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

A component process model of S_1-R_2 and S_2-R_1 transfer (Knight, 1973) assumed that St, R, F, and B components transfer from first list learning and that first list associative learning is bidirectional. Like Martin's (1965) model, the present models assumes that reponse learning preceeds associative learning. It also makes the additional assumption that stimulus differentiation preceeds acquisition of specific first list associations.

The component process model predicts that when the R component transfers maximally, the B component will procude a minimal amount of transfer. In a like manner maximal transfer from the St component would be expected to result in a minimal amount of transfer from the F component. Secondly, specific transfer contributed from the St component would be expected to produce a proportional amount of transfer from the R component and vice versa. In other words, associative learning will be retarded if either St differentiation or R learning is incomplete. Thus, if the secondary variable functions to enhance either St or R components, the associative learning is delayed, e.g., by using low m materials one would expect both an increased contribution from St and R components and as a consequence, a decreased contribution from F and B components. Hence, any prediction regarding net transfer effects with a particular paradigm varies as a function of m and DOL_1 on each transfer component.

B-A Transfer

According to the component process analysis, both S_1-R_2 and S_2-R_1 are identical. Thus all four components contribute to the net transfer effect. From all four surfaces 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.

B-A transfer shares positive components from response learning since first list response learning contributes positively to second list stimulus differentiation.

The acquisition of A-B associations, or forward associative learning from first list should make a positive contribution in a B-A paradigm via backward elicitation of B in the transfer list.

In the same way acquisition of backward associations during first list practice facilitiates second list learning via forward elicitation of A in a transfer list. Thus the interaction of all four component processes produce high positive transfer in a B-A paradigm.

C-A Transfer

Stimuli from the first and second lists are neutral in a C-A paradigm, therefore, the response learning and backward associative components do not contribute to the net transfer effect. The differentiation of first list stimuli should function to facilitate second list response learning compared to a C-D control group where Ss need to learn new response items.

First list forward association contributes a negative component via backward associative interference during second list acquisition. First list forward association interferes via backward associative interference when A responses in the second list elicit B which creates competition between first list B responses and second list C stimuli. Hence, net negative transfer will vary from + to - in this paradigm.

According to Houston's transfer surface, the C-A paradigm is viewed as similar to the traditional C-B paradigm in that both positive and negative components are assumed to summate yielding a zero net transfer effect. From the component viewpoint, a C-A paradigm will interact with secondary variables and the direction and degree of transfer in a C-A paradigm will vary compared to C-D learning.

B-C Transfer

The second list responses are neutral to first list responses and therefore stimulus and forward associative learning components do not contribute to the net negative transfer effect.

First list response learning should contribute positively to second list stimulus differentiation while first list backward associative learning interferes with forward associations during second list learning--since B elicits A and competes with second list responses.

Houston's transfer surface predicts maximal negative transfer for a B-C paradigm. The component process point of view predicts that a B-C paradigm, like a C-A paradigm, will vary from positive to negative. Direction and degree of transfer will vary from interaction with secondary variable.

Summary Table

	Component Process				
	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 -

Empirical Evidence

The empirical evidence in S_1-R_2 and S_2-R_1 transfer paradigms show evidence that several net transfer predictions are supported.

Houston's (1966a, 1966b) and Murdock's (1956) studies obtained only positive transfer in B-A paradigms when compared to C-D nonspecific control conditions. All three experiments used high m materials. Houston's experiments employed intermediate levels of DOL_1 (first-list learning was six trials) while Murdock (1956) used a one perfect first-list criterion. Their results are as predicted from a component process conception. By using high m materials and intermediate DOL_1 there should be an enhanced development of F and B component variables, thus facilitating second list learning. Secondly, a component process explanation of S_1-R_2, S_2-R_1 predicts positive transfer in a B-A paradigm regardless of the secondary variables involved because contributions from any of the four components is always positive.

The results of C-A paradigm studies are conflicting. Goulet and Barclay (1965), Houston (1966a), Murdock (1958), and Schuman (1967) obtained negative transfer in a C-A paradigm when compared to a C-D condition. Schulman (1967a, 1967b) obtained zero transfer in a C-A paradigm as predicted from Houston's transfer surface. Homzie et al (1969) obtained positive transfer in C-A condition.

Studies which obtained negative transfer in the C-A paradigm used either intermediate or high level of DOL_1 except the Goulet and Barclay (1965) experiment. Three other studies used high m materials. Goulet and Barclay used infrequently printed English words for list material, but DOL_1 was set at three consecutive errorless trials.

Houston (1966a) reported zero transfer on the first trial of the second list, but in terms of the total second list C-A he found negative transfer. This suggests that negative transfer in a C-A paradigm is due to associative interference from high DOL_1 learning and high m materials which enhance the contribution from the F component rather than the St component.

Both Schulman studies (1967a and 1967b) used 1/10 or 5/10 correct responses as first list learning while Schulman (1967b) used a 3/7 correct response criterion. Secondly, materials were of low meaningfulness. This suggests that the St component of transfer is enhanced when lower _m_ materials or low degree of list 1 learning is used.

Homzie _et al_ (1969) obtained positive transfer in C-A and C-B paradigms when interlist response similarity was high and list one was learned until one perfect trial plus one additional trial. The authors concluded that stimulus learning during first list acquisition and highly similar first list stimuli (C-A or C-B) responses contribute to positive transfer.

Harcum (1953) reported data for the C-A paradigm which is contradictory to the prediction derived from a component process. He used first list learning of two perfect trials and CVC list materials. The _m_ value of the CVC list is not reported. Performance in the C-A paradigm was zero. One would predict negative transfer in a C-A paradigm since high DOL_1 learning enhances the contribution from forward associative interference. Since _m_ value is not reported no definite conclusion can be drawn. With low _m_ CVC material, an enhanced contribution from the St component may facilitate learning in the second list.

Schulman (1967b) reported zero transfer in a B-C paradigm, while the rest of the studies obtained negative transfer (Goulet & Barclay, 1965; Harcum, 1953; Houston, 1966a,b; and Murdock, 1958).

Schulman's (1967b) results are predicted from a component process conception of transfer since use of low DOL_1 (3/7 CR) and intermediate _m_ materials would be expected to enhance the contribution from first-list response learning to second-list stimulus differentiation (R component) and minimize the associative interference component.

Both Houston's study (1966a, 1966b) and Murdock's (1958) experiments used high _m_ materials and intermediate or high levels of first list practice. Hence, first list associative learning is facilitated. This contributes to backward associative components resulting in the predicted negative transfer. Goulet did use low m material, but had high DOL_1 learning while Harcum's m level of list material is not reported.

Knight (1973) carried out an experiment where all four paradigms (C-A, B-C, B-A, and C-D) were tested under two levels of m (high and low) and three levels of DOL_1 (3/6. 6/6 or 6/6 + 50%). The results showed positive transfer in the B-A paradigm with magnitude of positive transfer increasing as DOL_1 learning increased. For both the low and high m conditions, B-A transfer was observed to be solely positive. This is in agreement with previous results obtained by Houston (1966a, 1966b) and Murdock (1956). These data support the component process model prediction of positive transfer in a B-A paradigm. In a C-A paradigm, Knight obtained positive transfer for high m and low DOL_1 learning while negative transfer resulted from high m and intermediate DOL_1 learning.

The present data, and those of Goulet and Barclay (1965), Homzie et al (1969), Murdock (1958) and Schulman (1967) are in sharp contrast to the prediction of zero transfer in a C-A paradigm derived from Houston's (1964) transfer surface. This suggests that the secondary variables m and DOL_1 either enhance or diminish the St and F component process variables, thus producing either positive or negative net transfer effect.

In a B-C paradigm, negative transfer was obtained with high m materials and intermediate or high DOL_1 and low m and high DOL_1. This evidence supports Houston's arguement that the B-C paradigm is a negative transfer paradigm producing net transfer effects similar to those observed in the traditional A-C paradigm. However, low DOL_1 should produce positive transfer with both high and low m material. This suggests that the present data do not agree with an analogy between B-C and A-C transfer paradigms. It should be noted that B-C paradigms have a stronger stimulus differentiation component (since second list stimuli were learned as first list responses) and a weaker associative component. Thus, greater positive transfer with a low DOL_1 and less negative transfer with a high DOL_1 for B-C relative to A-C is as predicted from a component process analysis. This prediction of course needs to be tested since Knight's experiments do not use an A-C paradigm.

Secondary Variable

Osgood's transfer surface makes no prediction about how secondary variables like degree of list 1 learning (DOL_1) and response meaningfulness (m) would interact with direction and magnitude of transfer.

Martin's component model predicts that net transfer effects vary depending upon the interaction with DOL_1 and m. Thus, a lower degree of first list learning and lower response m enhance positive transfer in an A-B, C-B paradigm since they maximize transfer of the positive component or response learning, while minimizing the negative component of backward associations. While in an A-C paradigm lower DOL_1 and lower m produce less negative transfer since such factors minimize FAL which is assumed to produce negative transfer.

When DOL_1 learning is zero all surfaces collapse into a zero plane. For a C-B paradigm only R and B components interact with DOL_1 and m. With low DOL_1 one would predict positive transfer since RL preceeds AL. With high DOL_1 one would predict negative transfer since BA interference will be greater on the transfer list. With low m material, practice time would be consumed by RL and weak associative interference develops and therefore positive transfer would be expected. The advantage of RL with low m in a C-B paradigm over a C-D paradigm decreases as DOL_1 increases. Therefore, the positive transfer effect decreases. With high m responses, RL is completed earlier and therefore AL would be maximized. Low DOL_1 and high $\underline{m}$ responses should decrease negative transfer, but when DOL_1 is high and $\underline{m}$ is high, negative transfer is predicted.

For an A-C paradigm, only F components interact with the secondary variables. As DOL_1 increases, amount of negative transfer should increase. With low DOL_1 negative transfer should decrease. When $\underline{m}$ and DOL_1 increases, amount of negative transfer should increase since FAL increases.

Degree of First List Learning

The two stage analysis assumes that with low DOL_1, RL will be the dominant source of transfer; but as DOL_1 increases, associative factors will become increasingly important.

Bruce (1933) varied DOL_1 from 6 to 12 trials using a 9-pair CVC list and found that negative transfer increases as the DOL_1 learning increases in C-B and A-C paradigms. Atwar (1953) and Underwood (1951) varied DOL_1 learning in an A-C paradigm and found that the negative transfer effect decreases as DOL_1 increases. However, these studies did not include control groups. Mandler (1956) using a within design, and varying DOL_1 (0, 10, 30, 50 or 100 trials), reported that as DOL_1 increases, positive transfer in both C-B and A-Br paradigms was obtained. Negative transfer was found for A-C following 10 errorless trials. Positive transfer was found after 30 or 50 trials and negative transfer after 100 trials. This difference was non-significant.

Jung (1962) varied DOL_1 (3/6 correct reponse or 6/6 + 5 trials) in C-B, A-C, A-Br and C-D paradigms. As DOL_1 increases, negative transfer decreases in A-C and A-Br paradigms. In the C-B paradigm there is a transfer shift from positive to negative as DOL_1 increases. Dean and Kausler (1964) also reported similar results using high $\underline{m}$ CVCs as stimuli and responses and varying DOL_1 learning (3/6 or 6/6 + 5 additional trials). They reported a shift from positive to negative transfer in the C-B paradigm as DOL_1 increases.

Jung used adjectives as stimuli and trigrams as responses. Dean and Kausler used high m CVCs for both stimuli and responses. Postman used high m adjectives for both stimuli and responses in C-B, A-C, A-Br and C-D paradigms. DOL_1 was varied (6/10, 10/10 or 10/10 + 50% overlearning). Negative transfer decreased in A-C and C-B paradigms as DOL_1 increased, but the magnitude of negative transfer increased as DOL_1 increased in an A-Br paradigm.

Homzie, Weimer, Schwartz, and Waters (1969) supported the notions of component processes in transfer and interactions with secondary variables. These authors argued that as DOL_1 increases in C-B and A-Br paradigms, response learning will be facilitated while associative learning will be inhibited. When the degree of intralist response similarity (IRS) increases, reponse learning will be enhanced with DOL_1 increases. With low IRS, however, there should be less facilitative effects as DOL_1 increases. When transfer list responses are first-list stimuli (e.g., C-A and Br-A) IRS does not have a potent effect and therefore IRS and DOL_1 interactions would not be expected in these two paradigms. The design had two levels of IRS (high vs. low) x two levels of DOL_1 (3/6 vs. 6/6 + 1 study trial) x 5 paradigms (C-B, C-A, A-Br, Br-A and C-D). They used CVC responses and adjectives as stimuli. For high IRS, 3 consonants were used while for low IRS, 12 difference consonants were used.

The analysis showed a significant paradigm effect. The C-B paradigm performance was better than the C-A paradigm while A-Br performance was better than Br-A, DOL_1 and paradigm effects were significant as predicted.

For the C-B and A-Br conditions positive transfer was evident only with high IRS and no differences were found with low IRS. This was as predicted. For C-A and B-Ar paradigms, DOL_1 by paradigm interaction were significant. High IRS performance was better in these two conditions than low IRS. This is contrary to their prediction that stimulus learning is equivalent to response learning in first list acquisition.

Schulman (1967) had two levels of DOL_1 in A-Br, A-C, C-A and C-D paradigms. DOL_1 was either 1/10 correct responses or 5/10 correct responses. It was reasoned that for low DOL_1, the major transfer component would result from response learning. An A-C paradigm should provide forward associative interference for an A-Br paradigm while a C-A paradigm will provide backward associative interference for an A-Br paradigm. Ten pair lists of CVC stimuli and high frequency noun responses were used. There was no significant difference obtained from DOL_1. With 1/10, A-C and A-Br were significantly inferior to C-A and C-D. While with a 5/10 criterion, A-Br was significantly inferior to A-C. This supports Martin's component analysis that increased associative learning produces greater interference during second list acquisition.

The data on DOL_1 are in conflict when overlearning is employed. Increasing negative transfer as DOL_1 increases as predicted from component process model is not consistently found. The R learning component prediction was confirmed, but data on the associative learning components are in conflict. According to Martin's component process model, associative learning should increase as DOL_1 increases. The evidence shows that increased associative learning first increases and then decreases as DOL_1 increases.

Meaningfulness

Martin's component analysis predicts that in a C-B paradigm, response learning should be greater with low m responses. High m responses should lead to less positive or even greater negative transfer. Mandler and Heinemann (1956) found that the A-Br paradigm yielded positive transfer while the A-C paradigm showed neither consistent positive nor negative transfer. It should be noted that Mandler and Heinemann used low-meaningful (consonant and syllable) responses. Their results suggest that shifts from negative to positive transfer under an A-Br paradigm are due to low response meaningfulness.

Merikle and Battig (1963) studied transfer under A-Br, A-C and C-D paradigms. They also compared three levels of m materials. They replicated Mandler's and Heinemann's studies and obtained positive transfer in an A-Br paradigm with low m material, and strong negative transfer with high m material. High m results in A-Br and A-C paradigms closely corresponding to previous studies (Besch & Reynolds, 1958; Postmann, 1962; Twedt & Underwood, 1959). It should be noted that both Mandler and Heinemann used mixed list designs. It is possible that the positive A-Br transfer with low m lists may reflect some factors unique to mixed list conditions.

Goulet (1965) factorially varied the m of responses in first and second lists. The level of response m was either high (H) or low (L) on both lists, making four conditions: H_1-H_2, L_1-L_2, H_1-L_2, L_1-H_2. Stimuli were adjectives and responses were nonsense syllables selected from Archer (1960). The mean association value for responses in the low m list was 14% while for high m list it was 93%. The results showed that high m responses in list one provide the potent source of negative transfer in an A-C paradigm, i.e., H_1-H_2 and H_1-L_2 conditions.

Merikle (1968) varied both St and R m factorially in A-C, A-Br, C-B, and C-D paradigms. Thus high and low levels of m yield four conditions within each paradigm: H-H, H-L, L-H, and L-L. He used a study-test procedure with pairs being dropped following a correct response. The results showed some support for the component process model with an A-C paradigm. With H-H condition, significant negative transfer was observed. This is expected due to greater associative A-B acquisition. In L-H condition, negative transfer was low. This was contradictory to Merikle and Battig since responses were high m. In H-L and L-L condition zero negative transfer was obtained. With low m responses learning should be difficult resulting in less associative interference.

In the C-B paradigm, positive transfer decreased as response m was increased. This is contradictory to Jung (1962) and Dean and Kausler (1964). They obtained negative transfer with high m responses. Again in H-H condition, A-C Ss were inferior to A-Br Ss. This again contradicts the component analysis. It is possible that when correct response pairs are being dropped, the strong development of backward associations may be prevented in this paradigm.

There is substantial evidence that with high m responses there is greater associative interference. Therefore, with increased response m would increase negative transfer. With low response m, greater time is required to learn the responses and there is not much associative interference developed. Therefore with low m responses, positive transfer should also be obtained in an A-Br paradigm where both forward and backward associative interference components summate in a net transfer effect. High or low response of m does not have a very strong effect in an A-C paradigm as would be expected from the component process analysis.

Factorial investigation of level of response m and DOL_1 would be highly desirable and will give much light to the role of secondary variables in the component analysis of transfer.

Verbal Discrimination Transfer

Two major theoretical views have been forwarded in examining transfer phenomena in verbal discrimination learning: One view is a frequency theory and the other is a component analysis tradition of paired-associate (PA) transfer.

Ekstrand, Wallace and Underwood (1966) proposed a frequency theory to explain the process of verbal discrimination (VD) learning. According to frequency theory, the frequency differential between right (R) and wrong (W) items in a VD pair provides the basis for discrimination. Ekstrand et al. applied this theory to the VD transfer effect. To account for VD transfer they assumed two rules for VD tasks. If the transfer list involves old R but new W items (W_1-R_1, W_2-R_1), performance is optimized using a Rule 1 strategy (Rule 1 = select the most frequent items). If the transfer list involves new R items but old W items (W_1-R_1, W_1-R_2), performance is optimized by the use of a Rule 2 strategy (Rule 2 = select less frequent items). If the subject adapts a rule 2 strategy then as acquisition progresses, the frequency differential between W_1 and R_2 is approximately equal, making discrimination more difficult. At this point, Ss cannot choose their rules effectively and eventually change to Rule 1. Negative transfer would thus be obtained in later stages of list 2 practice.

Kausler (1966) proposed an extension of multiple component analysis of PA transfer to explain VD transfer. Kausler's multiple-component analysis of VD transfer assumed that in VD learning both intentional and incidental associations build up between R and W items in VD tasks. The incidental associations are subject to interference like intentionally learned associations. In other words, the W_1-R_1 and W_1-R_2 associations enter into a competitional unlearning (A-B, A-C) relationship.

Underwood, Jesse, and Ekstrand (1964) presented evidence in support of frequency theory predictions by employing three transfer conditions: A nonspecific transfer control containing two unrelated lists (W_1-R_1, W_2-R_2); a right condition where R items were the same on both lists and were paired with new W items on list 2 (W_1-R_1, W_2-R_1); and a wrong condition where W items were the same with new R items on list 2 (W_1-R_1, W_1-R_2). Data supported rule 1 in the W_2-R_1 paradigm and rule 2 in the W_1-R_2 paradigm compared to the W_2-R_2 control condition.

Support for the frequency theory has been found by Raskin, Boice, Rubel, and Clark (1968). They used two backward paradigms in which W and R items were reversed on the second list (W_1-R_1, W_R-R_W), and W items of the second list were new. Right items of the second list were wrong in the first list (W_1-R_1, W_2-R_W). Since the same pairs are presented on both lists in a W_R-R_W paradigm, according to frequency theory there should be nearly perfect performance on early trials followed by a decrement in performance on later trials, using rule 2 strategy. However, such a decrement would not be expected in a W_2-R_W paradigm. They obtained results as predicted by frequency theory.

King and Levin (1971) tested the frequency theory in VD transfer by varying list one trials in two different paradigms: W_1-R_1, W_1-R_2 and W_1-R_1, W_R-R_2. According to frequency theory predictions, both groups should perform better than a control group on early list 2 trials but poorer on later trials. The effect of varying degree of list 1 learning should be more pronounced in a W_R-R_2 paradigm group than in a W_1-R_2 paradigm group since in the W_R-R_2 group greater frequency builds up for the list 1 R items than for the list 1 W items. Transfer performance in the present study was consistent with frequency theory predictions.

Wallace, Remington and Beito (1972) supported frequency theory by using a study-test method with two paradigms (W_1-R_1, W_1-R_2 and W_1-R_1, W_2-R_1). The control group learned only W_1-R_1 and did not learn a second list. Thus, there is strong support for the frequency theory in VD transfer.

In an extension of the Underwood et al study (1964) Kausler and Dean (1967) used a mixed list and obtained positive transfer in a W_1-R_1, W_2-R_1 paradigm, but found negative transfer throughout the second list in a W_1-R_1, W_1-R_2 paradigm. Furthermore, mediated negative transfer also occurred when the W items of list 1 and list 2 were word associates of one another rather than identical terms (W_1-R_1, W'_1-R_2). Kausler, Fulkerson and Eschenbrenner (1967) used a between -S design and obtained further evidence for lack of positive transfer in the early trials of a W_1-R_1, W_1-R_2 paradigm. Thus, these studies support component theory rather than frequency theory. Support for the competition unlearning hypothesis was obtained by Kausler, et al. (1967) and Eschenbrenner and Kausler (1968) in W_1-R_1, W_1-R_2 and W_1-R_1, W_2-R_1 paradigms. They used a modified free recall procedure. The W_1 recall for W_2-R_1 Ss was inferior to both W_2-R_2 Ss and normal forgetting control Ss.

Strong support for a component theory of VD transfer was found by Kanak and Dean (1969). In a series of two experiments they demonstrated an interaction between frequency based mechanisms and incidentally learned associative interference in transfer of VD learning. The major prupose of experiment one was to establish primary transfer laws which could be used to establish a transfer surface for the VD task. They predicted: (1)

When W items are varied and R items are identical, positive transfer should be obtained with magnitude increasing as the interlist associative relationship between W items increases. (2) When W items are identical and R items are varied, negative transfer should be obtained with magnitude decreasing as the interlist associative relationship between R items increases. Experiment one data supported both predictions. Kanak and Dean concluded that the frequency cue generally determine the direction of transfer while an associative mechanism accounts for the degree of transfer. Experiment II extended the analysis of the VD transfer effect in which repairing of list 1 W and R items occurs on list 2. Frequency theory would predict the null hypothesis since the role of the frequency mechanism is equated in both lists. An associative account, on the other hand, would predict interference from competing W-R and R-W associations under conditions of repairing, leading, therefore, to negative transfer. Their data clearly support the role of the associative mechanism. This phenomenon was again supported by Kanak and Knight (1974).

Backward VD Transfer Surface

Kanak and Dean proposed a forward transfer surface in VD tasks. It would seem desirable, therefore, to test transfer surfaces for a backward paradigm by manipulating W_1-R_2 and W_2-R_1 similarity rather than W_1-W_2 and R_1-R_2 similarity.

REFERENCES

Archer, E.J. A re-evaluation of the meaningfulness of all possible CVC trigrams. Psychological Monographs, 1960, 74 (No. 10), (Whole No. 497).

Atwater, S.K. Proactive inhibition and associative facilitation as affected by degree of prior learning. Journal of Experimental Psychology, 1953, 46, 400-404.

Barnes, J. M. & Underwood, B. J. "Fate" of first-list associations in transfer theory. Journal of Experimental Psychology, 1959, 58, 97-105.

Bastion, J. Associative factors in verbal transfer. Journal of Experimental Psychology, 1961, 62, 70-74.

Besch, N. F. & Reynolds, W. F. Associative interference in verbal paired-associate learning. Journal of Experimental Psychology, 1958, 55, 554-558.

Bryk, J. A. & Kausler, D. H. Stimulus meaningfulness and unlearning in the A-B, A-C transfer paradigm. Journal of Experimental Psychology, 1966, 77, 917-920.

Bruce, R. W. Conditions of transfer of training. Journal of Experimental Psychology, 1933, 16, 343-361.

Bugelski, B. R. & Cadwallader, F. C. A reappraisal of the transfer and retroaction surface. Journal of Experimental Psychology, 1956, 52, 360-366.

Crouse, J. H. Paired-associate learning in five alternating-list transfer paradigms. Journal of Verbal Learning and Verbal Behavior, 1968, 7, 117-121.

Dallett, K. M. The transfer surface re-examined. Journal of Verbal Learning and Verbal Behavior, 1962, 1, 91-94.

D'Amato, M. F. & Rugger, K. Semantic and associative factors in transfer. Psychonomic Science, 1971, 23, 399-400.

Dean, M. G. & Kausler, D. H. Degree of first-list learning and stimulus meaningfulness as related to transfer in the A-B, C-B paradigm. Journal of Verbal Learning and Verbal Behavior, 1964, 3, 330-334.

Ellis, A. C. Transfer of stimu-us predifferentiation to shape recognition and identification learning: Role of properties of verbal labels. Journal of Experimental Psychology, 1968, 78, 401-409.

Ekstrand, B. R., Wallace, W. P. & Underwood, B. J. A frequency theory of verbal discrimination learning. Psychological Review, 1966, 73, 566-578.

Eschenbrenner, A. J. & Kausler, D. H. Unlearning of list 1 wrong items in verbal discrimination transfer. Journal of Experimental Psychology, 1968, 78, 696-698.

Gibson, E. J. A systematic application of the concepts of generalization and differentiation to verbal learning. Psychological Review, 1940, 47, 196-229.

Gibson, E. J. Retroactive inhibition as a function of degree of generalization between tasks. Journal of Experimental Psychology, 1941, 28, 93-115.

Glaze, S. A. The association value of nonsense syllables. Journal of Genetic Psychology, 1928, 35, 255-267.

Goulet, L. R. Interlist response meaningfulness and transfer effects under the A-B, A-C paradigm. Journal of Experimental Psychology, 1965, 70, 264-269.

Goulet, L. R. & Barclay, A. Comparison of paired-associate transfer effects between the A-B, C-A and A-B, B-C transfer paradigms. Journal of Experimental Psychology, 1965, 70, 537-539.

Goulet, L. R. & Behar, V. Bidirectional paired-associate learning and transfer effects in the A-B, C-B and A-B, A-C paradigms. Psychonomic Science, 1966, 6, 299-300.

Hall, J. F. Verbal learning and retention. Philadelphia: J. B. Lippincott, 1971.

Hamilton, R. J. Retroactive facilitation as a function of degree of generalization between tasks. Journal of Experimental Psychology, 1943, 32, 363-376.

Harcum, E. R. Verbal transfer of overlearned forward and backward associations. American Journal of Psychology, 1953, 66, 622-625.

Houston, J. P. Verbal transfer and interlist similarities. Psychological Review, 1964, 71, 412-414.

Houston, J. P. A repaired S_1-R_2 and S_2-R_1 transfer surface. Psychonomic Science, 1965, 3, 343-344.

Houston, J. P. Verbal transfer as a function of S_1-R_2 and S_2-R_1 interlist similarity. Journal of Experimental Psychology, 1966a, 71, 232-235.

Houston, J. P. Supplementary Report: Transfer as a function of the similarity between first-list stimuli and second-list responses. Journal of Verbal Learning and Verbal Behavior, 1966b, 5, 322-323.

Houston, J. P. & Morony, L. D. Transfer in repaired S_1-R_2 and S_2-R_1 paradigms. Psychonomic Science, 1966, 4, 83.

Jenkins, J. J., Foss, D. J., & Odom, P. B. Associative mediations in paired-associate learning with multiple controls. Journal of Verbal Learning and Verbal Behavior, 1965, 4, 141-147.

Johnston, W. A. Bidirectional interference in an A-B, C-B paradigm. Journal of Verbal Learning and Verbal Behavior, 1968, 7, 305-311.

Jung, J. Transfer of training as a function of degree of first-list learning. Journal of Verbal Learning and Verbal Behavior, 1962, 1, 197-199.

Jung, J. Effects of response meaningfulness (m) in transfer of training under two different paradigms. Journal of Experimental Psychology, 1963, 65, 377-384.

Jung, J. Comments on Mandler's "From association to Structure." Psychological Review, 1965, 72, 318-322.

Jung, J. Differentiation and negative transfer as a function of degree of first and second-list learning. Psychological Reports, 1967, 21, 73-80.

Jung, J. Prevention of unlearning in verbal transfer by first-list reinstatement. Journal of Experimental Psychology, 1970, 83, 354-355.

Kausler, D. H. Readings in Verbal Learning. New York: John Wiley & Sons, 1966.

Kausler, D. H. & Dean, M. G. Direct and mediated transfer for right and wrong responses in verbal-discrimination learning. Journal of Verbal Learning and Verbal Behavior, 1967, 6, 672-674.

Kausler, D. H., Fulkerson, E. E. & Eschenbrenner, A. J. Unlearning of list 1 right items in verbal discrimination transfer. Journal of Experimental Psychology, 1967, 75, 379-385.

Kausler, D. H. & Kanoti, G. A. R-S learning and negative transfer effects with a mixed list. Journal of Experimental Psychology, 1963, 65, 201-205.

Kanak, N. J. & Dean, M. F. Transfer mechanisms in verbal discrimination. Journal of Experimental Psychology, 1969, 79, 300-307.

Kennelly, K. J. Stimulus differentiation in the A-B, A-C paradigm, artifact or fact: Some additional evidence. Presented at the Southwestern Psychological Association, St. Louis, April, 1970.

Keppel, G. & Postman, L. Studies of learning to learn: III. Conditions of improvement in successive transfer tasks. Journal of Verbal Learning and Verbal Behavior, 1966, 5, 260-267.

Knight, M. Mechanisms of transfer in S_1-R_2 and S_2-R_1 paradigms. Unpublished Dissertation, University of Oklahoma, 1973.

Mandler, G. & Heinemann, S. H. Effect of overlearning of a verbal response on transfer of training. Journal of Experimental Psychology, 1956, 51, 39-46.

Martin, E. Transfer of verbal paired-associates. Psychological Review, 1965, 72, 327-343.

McGovern, J. B. Extinction of associations in four transfer paradigms. Psychological Monographs, 1964, 78 (16, whole No. 593).

Merikle, P. M. Paired-associate transfer as a function of stimulus and response meaningfulness. Psychological Reports, 1968, 22, 131-138.

Merikle, P. M. & Batting, W. F. Transfer of training as a function of experimental paradigm and meaningfulness. Journal of Verbal Learning and Verbal Behavior, 1963, 2, 485-488.

Morgan, R. I. & Underwood, B. J. Proactive inhibition as a function of response similarity. Journal of Experimental Psychology, 1950, 40, 592-603.

Murdock, B. B. "Backward" learning in paired-associates. Journal of Experimental Psychology, 1956, 51, 213-215.

Murdock, B. B. "Backward" associations in transfer and learning. Journal of Experimental Psychology, 1958, 55, 111-114.

Mull, J. R. & Richman C. L. Positive transfer found in an A-C paradigm. Journal of Experimental Psychology, 1973, 99, (3), 424-426.

Muller, G. E. & Schumann, F. Experimentelle Beitrage zur Untersuchung des Gedachtnisses. Zeitschrift fur Psychologie, 1894, 6, 81-90.

Noble, L. E. Measurements of association value (a), rated associations (a') and scaled meaningfulness (m') for the 2100 CVC combinations of the English alphabet. Psychological Reports, 1961, 8, 487-521.

Olivier, K. & Kausler, D. H. Transfer in the A-B, C-B paradigm as a function of stimulus class. Psychonomic Science, 1966, 5, 47-48.

Osgood, C. E. Meaningful similarity and interference in learning. Journal of Experimental Psychology, 1946, 36, 277-301.

Osgood, C. E. An investigation into the causes of retroactive interference. Journal of Experimental Psychology, 1948, 38, 132-154.

Osgood, C. E. The similarity paradox in human learning: A resolution. Psychological Review, 1949, 56, 132-143.

Palermo, D. S. & Jenkins, J. J. Word Association Norms. Minneapolis, Minnesota: University of Minnesota Press, 1964.

Poffenberger, A. T. The influence of improvement in one simple mental process upon other related processes. Journal of Educational Psychology, 1915, 6, 459-474.

Postman, L. Transfer of training as a function of experimental paradigm and degree of first-list learning. Journal of Verbal Learning and Verbal Behavior, 1962, 1, 109-118.

Postman, L. Transfer, interference and forgetting. In J. W. Kling and L. A. Riggs (Eds.). Woodworth and Schlosberg's Experimental Psychology. New York: Holt, Rinehart and Winston, Inc., 1971, 1019-1132.

Postman, L. & Stark, K. The role of response availability in transfer and interference. Journal of Experimental Psychology, 1969, 79, 168-177.

Raskin, D. C., Boice, C., Rubel, E. W., & Clark, D. Transfer tests of the frequency theory of verbal discrimination learning. Journal of Experimental Psychology, 1968, 76, 521-529.

Richardson, J. Transfer and the A-B anticipation interval in the A-B; A-B' paradigm. Journal of Verbal Learning and Verbal Behavior, 1967a, 6, 897-902.

Richardson, J. Latencies of implicit verbal responses and the effect of the anticipation interval on mediated transfer. Journal of Verbal Learning and Verbal Behavior, 1967b, 6, 819-826.

Richardson, J. Latencies of implicit associative responses and positive transfer in paired-associate learning. Journal of Verbal Learning and Verbal Behavior, 1968, 7, 638-646.

Richardson, J. & Brown, B. L. Mediated transfer in paired-associate learning as a function of presentation rate and stimulus meningfulness. Journal of Experimental Psychology, 1966, 72, 820-828.

Saravo, A. C. & Price, L. E. Associative transfer in verbal paired-associate learning as a function of stimulus similarity. Psychonomic Science, 1967, 8, 315-316.

Schwartz, M. Effect of stimulus class on transfer and RI in the A-B, C-B paradigm. Journal of Verbal Learning and Verbal Behavior, 1968, 7, 189-195.

Schulman, R. M. Paired-associate transfer for the A-B, C-A and the A-B, B-C paradigm. Psychological Reports, 1967a, 20, 1043-1050.

Schulman, R. M. The effect of unidirectional primary word associations on A-B, C-A paired-associate transfer. Psychonomic Science, 1967b, 8(8), 323-324.

Schulman, R. M. Paired-associate transfer following early stages of List 1 learning. Journal of Experimental Psychology, 1967c, 73, 589-594.

Schulman, R. M. Paired-associate transfer as a function of ability level in the A-B, C-A and the A-B, B-C paradigms. Psychological Reports, 1968, 22, 203-210.

Schulman, R. M. Bidirectional List 2 learning and the A-B, C-A transfer paradigm. Psychonomic Science, 1968, 12(6), 275-276.

Shea, M. A generalization surface for the simultaneous variation of stimulus and response similarity. Journal of Experimental Psychology, 1969, 80, 353-358.

Slamecka, N. J. Transfer with mixed and unmixed lists as a function of semantic relations. Journal of Experimental Psychology, 1967, 73, 405-410.

Spear, N. E., Mikulka, P. J. & Podd, M. Transfer as a function of time to mediate. Journal of Experimental Psychology, 1966, 72, 40-46.

Stark, K. Components of transfer in the A-B, A-B' paradigm. Journal of Experimental Psychology, 1973, 97(3), 378-386.

Thorndike, E. L. & Lorge, I. The teachers word book of 30,000 words. New York: Teachers College, Columbia University Press, 1944.

Thune, L. E. & Underwood, B. J. Retroactive inhibition as a function of degree of interpolated learning. Journal of Experimental Psychology, 1943, 32, 185-200.

Twedt, H. M. & Underwood, B. J. Mixed vs. unmixed lists in transfer studies. Journal of Experimental Psychology, 1959, 58, 111-116.

Underwood, B. J. Associative transfer in verbal learning as a function of response similarity and degree of first-list learning. Journal of Experimental Psychology, 1951, 42, 44-53.

Underwood, B. J. An evaluation of the Gibson Theory of verbal learning. In C. N. Cofer (Ed.), Verbal Learning and Verbal Behavior. New York: McGraw-Hill, 1961, 197-216.

Underwood, B. J. Experimental Psychology. New York: Appleton-Century Crofts, 1949.

Underwood, B. J. Interference and forgetting. Psychological Review, 1957, 64, 49-60.

Underwood, B. J. & Ekstrand, B. R. Differentiation among stimuli as a factor in transfer performance. Journal of Verbal Learning and Verbal Behavior, 1968, 7, 172-175.

Underwood, B. J. & Freund, J. S. Transfer of stimulus discrimination: Can response terms be used to differentiate stimulus terms? Journal of Verbal Learning and Verbal Behavior, 1968, 7, 825-830.

Underwood, B. J., Jesse, F., & Ekstrand, B. R. Knowledge of rights and wrongs in verbal-discrimination learning. Journal of Verbal Learning and Verbal Behavior, 1964, 3, 183-186.

Underwood, B. J., Runquist, W. N. & Schulz, R. W. Response learning in paired-associate lists as a function of intralist similarity. Journal of Experimental Psychology, 1959, 58, 70-80.

Underwood, B. J. & Schulz, R. W. Meaningfulness and Verbal Learning. Philadelphia: Lippincott, 1960.

Wimer, R. Osgood's transfer surface: Extension and test. Journal of Verbal Learning and Verbal Behavior, 1964, 3, 274-279.

Wylie, H. H. An experimental study of transfer of response in the white rat. Behavior Monographs, 1919, No. 16.

Young, R. K. Retroactive and Proactive effects under varying conditions of response similarity. Journal of Experimental Psychology, 1955, 50, 113-119.

APPENDIX B

WORD LISTS

Word List - A_1 for ${}^{W}R_1$-R_2, W_2-${}^{R}W_1$, W_1-R_1, and W_2-R_2 paradigms

${}^{W}R_1$-R_2

Style	Hide
Glory	Series
Anger	Quantity
Person	Expression
Air	Silence
Power	Interest
Marriage	Direction
Virtue	Life
Colony	Time
Brain	Contract
Dream	Present
Fortune	Vegetable

W_1-R_1

Hour	Vegetable
Anger	Salary
Time	Speech
Fun	Power
Series	Justice
Author	Hide
Person	Vessel
Life	Plain
Length	Dream
Form	Marriage
Brain	Heaven
Artist	Silence

W_2-${}^{R}W_1$

Creature	Hour
Author	Property
Opportunity	Artist
Passion	Vessel
Length	Charm
Form	Cost
Appearance	Heaven
Advice	Plain
Salary	Trouble
Confidence	Fun
Justice	Science
Speech	Duty

W_2-R_2

Property	Virtue
Direction	Creature
Opportunity	Style
Contract	Appearance
Duty	Fortune
Glory	Advice
Air	Cost
Confidence	Interest
Passion	Colony
Expression	Science
Present	Charm
Trouble	Quantity

Word List - A_2 for ${}^{W}R_1$-R_2, W_2-${}^{R}W_1$, W_1-R_1, and W_2-R_2 paradigms

${}^{W}R_1$-R_2

Creature	Hour
Author	Property
Opportunity	Artist
Passion	Vessel
Length	Charm
Form	Cost
Appearance	Heaven
Advice	Plain
Salary	Trouble
Confidence	Fun
Justice	Science
Speech	Duty

W_1-R_1

Hour	Vegetable
Anger	Salary
Time	Speech
Fun	Power
Series	Justice
Author	Hide
Person	Vessel
Life	Plain
Length	Dream
Form	Marriage
Brain	Heaven
Artist	Silence

W_2-${}^{R}W_1$

Style	Hide
Glory	Series
Anger	Quantity
Person	Expression
Air	Silence
Power	Interest
Marriage	Direction
Virtue	Life
Colony	Time
Brain	Contract
Dream	Present
Fortune	Vegetable

W_2-R_2

Property	Virtue
Direction	Creature
Opportunity	Style
Contact	Appearance
Duty	Fortune
Glory	Advice
Air	Cost
Confidence	Interest
Passion	Colony
Expression	Science
Present	Charm
Trouble	Quantity

Word List - A_1 for ${}^{W}R_1-{}^{R'}W_1$ and ${}^{W'}R_1-{}^{R}W_1$ for C-NC conditions

${}^{W}R_1-{}^{R'}W_1$

Corresponding		Noncorresponding	
Minute	Vegetable	Silence	Simple
Anger	Money	Paint	Power
Time	Talk	Talk	Vegetable
Play	Power	Series	God
Series	Law	Marriage	Book
Book	Hide	Minute	Anger
Person	Ship	Time	Law
Life	Simple	Play	Brain
Long	Dream	Life	Shape
Shape	Marriage	Ship	Dream
Brain	Gold	Hide	Money
Paint	Silence	Long	Person

${}^{W'}R_1-{}^{R}W_1$

Hour	Fruit	Mad	Hour
Mad	Salary	Sleep	Vessel
Clock	Speech	Fun	Think
Fun	Strength	Quiet	Plain
World	Justice	Salary	Seek
Author	Seek	Heaven	World
People	Vessel	People	Length
Death	Plain	Form	Death
Length	Sleep	Speech	Fruit
Form	Love	Love	Author
Think	Heaven	Justice	Clock
Artist	Quiet	Artist	Strength

Word List - A_2 for ${}^{W}R_1 - {}^{R'}W_1$ and ${}^{W'}R_1 - {}^{R}W_1$ for C-NC conditions[1]

${}^{W}R_1 - {}^{R'}W_1$

Corresponding		Noncorresponding	
Hour	Fruit	Quiet	Plain
Mad	Salary	Artist	Strength
Clock	Speech	Speech	Fruit
Fun	Strength	World	Heaven
World	Justice	Love	Author
Author	Seek	Hour	Mad
People	Vessel	Clock	Justice
Death	Plain	Fun	Think
Length	Sleep	Death	Form
Form	Love	Vessel	Sleep
Think	Heaven	Seek	Salary
Artist	Quit	Length	People

${}^{W'}R_1 - {}^{R}W_1$

Minute	Vegetable	Silence	Simple
Anger	Money	Paint	Power
Time	Talk	Talk	Vegetable
Play	Power	Series	God
Series	Law	Marriage	Book
Book	Hide	Minute	Anger
Person	Ship	Time	Law
Life	Simple	Play	Brain
Long	Dream	Life	Shape
Shape	Marriage	Ship	Dream
Brain	God	Hide	Money
Paint	Silence	Long	Person

[1] List B involves different pairing.

APPENDIX C

INSTRUCTIONS

INSTRUCTIONS

List 1 Instructions

In the window of the memory drum pairs of common words will appear at the rate of one pair every two seconds. One of the words of each pair has been arbtrarily designated as "right" and the other as "wrong." Each pair will be exposed twice for two seconds each time, before a new pair appears. Your task is to learn to recognize and pronounce the "right" word during the first exposure. Please do not make any response during the second exposure. During the second exposure the "righ" word will be underlined to inform you if your selection is correct.

There are 12 pairs of words in the list. Four different order of the same list will appear, so that the position of pairs of words will vary with each presentation of the list. In addition, sometimes the "right" word of a pair will be on the left hand side and sometimes it will be on the right hand side. You should not, therefore, try to use either position in the list or left-right position to help you learn.

The first time the list is presented is guessing time. Guess at which word you think is correct during the first exposure to each pair. Right after you have guessed, the pair will appear again with one of the words underlined, so that when the pair comes again you know which word is the "right" and which word is the "wrong" word. The list will be presented over and over again until no mistakes are made on two consecutive presentations of the list. A series of stars designated the beginning of the list and a blank space designates its end.

The $^{W}R_1$-$^{R}W_1$ Paradigm Instructions

Procedure for learning the second list is same as the list you have just finished learning. There is some relationship existing between the list you have finished learning and the list you are about to learn. The first list "right" items are "wrong" items in the new list. In the same way, first list wrong items are right items in the new list.

The $^{W}R_1$-R_2 Paradigm Instructions

Procedure for learning the second list is same as the list you have just finished learning. There is some relationship existing between the list you have just finished learning and the new list you are about to learn. The first list "right items" become "wrong items" in the second list. The second list "wrong items" are paired with new "right items" in the second list.

The W_2-$^{R}W_1$ Paradigm Instructions

Procedure for learning the second list is same as the list you have just finished learning. There is some relationship existing between the list you have finished learning and the new list you are about to learn. The first list wrong items become right items in the second list which are now paired with new wrong items.

The $^{W}R_1$-$^{R}W_1$ Paradigm Instruction in C Conditions

I am now going to ask you to learn a second list. This list will be presented in the same procedure as the list you have first learned.

However, there is a relationship between the list you have just learned and the new list. The words which were wrong in the first list will be right in the second list, but words which were right in the first list will be wrong in the second list.

The ${}^{W}R_1$-${}^{R}W_1$ Paradigm Instruction in NC Condition

I am now going to ask you to learn a second list. This list will be presented in the same procedure as the list you have first learned.

However, there is a relationship between the list you have just learned and the new list. First, the words which were wrong in the first list will be right in the second list, but the words which were right in the first list will be wrong in the second list.

In adiditon, although the same words are involved and simply change between right and wrong, they will be paired differently in the second list. The information should help you to learn the second list.

The ${}^{W}R_1$-${}^{R'}W_1$ Paradigm Instructions in C Condition

I am now going to ask you to learn a second list. This list will be presented in the same procedure as the list you have first learned.

However, there is a relationship between the list you have just learned and the new list. The words which were right in the first list will be wrong in the new list but the words which were wrong in the first list will be replaced by the words which are associatively related and these words will now function as right items in new list.

The ${}^{W}R_1$-${}^{R'}W_1$ Paradigm Instructions in NC Condition

I am now going to ask you to learn a second list. This list will be presented in the same procedure as the list you have first learned.

However, there is a relationship between the list you have just learned and the new list. First, the words which were right in the first list will be wrong in the new list but the words which were wrong in the first list will be replaced by the words which are associatively related and these words will now function as right items in the new list. In addition, the words will be paired differently in the second list.

The ${}^{W'}R_1$-${}^{R}W_1$ Paradigm Instructions in C Conditions

I am now going to ask you to learr a second list. This list will be presented in the same procedure as the list you have first learned.

However, there is a relationship between the list you have just learned and the new list. First, the words which were wrong in the first list will be right in the new list, but the words which were right in the first list will be replaced by words which are associatively related and these will now be wrong items in the second list.

The ${}^{W'}R_1$-${}^{R}W_1$ Paradigm Instructions in NC Conditions

I am now going to ask you to learn a second list. This list will be presented in the same procedure as the list you have first learned.

However, there is a relationship between the list you have just learned and the new list. First, the words which were wrong in the first list will be right in the new list, but the words which were right in the first list will be replaced by words which are associatively related and these words now will be wrong items in the second list. In addition, the words will be paired differently in the second list.

The W_2-R_2 Paradigm Instructions

Procedure for learning the second list is same as the list you have just finished learning. There is no particular relationship existing between first list "wrong" and "right" items with the second list. The first and second list R and W items are not related from first list to second list.

List 2 Instructions under Noninstructed Conditions

Procedure for learning the second list is same as the list you have just finished learning.

APPENDIX D

SUMMARIES OF ANALYSIS OF VARIANCE

Summary of (Instruction x Paradigm)
Analysis of Variance on Percentage
of Transfer for Total Errors
of List 2 in Experiment I

Source	MS	df	F	P
Total	2351.968	71		
Between	13342.949	5		
A (Instruction)	35981.258	1	23.6825	.0001
B (Paradigm)	10766.625	2	7.0865	.0020
AB	4600.117	2	3.0278	.0537
Within	1519.318	66		

Summary of (Paradigm x Trial)

Analysis of Variance on Total Errors across 1-8

Trials on List 2 for Instructed Subjects in

Experiment I

Source	MS	df	F	P
Total	4.192	191		
Between	8.614	23		
A (Paradigm)	15.757	1	1.9009	.1790
%E (Errors)	8.289	22		
Within	3.587	168		
B (Trials)	36.267	7	29.0562	.0000
AB	22.362	7	17.9158	.0000
%E (Errors)	1.248	154		

Summary of (Paradigm x Trial)

Analysis of Variance on Total Errors across 1-8

Trials on List 2 for Noninstructed Subjects in

Experiment I

Source	MS	df	F	P
Total	2.917	383		
Between	5.785	47		
A (Paradigms)	16.823	3	3.3426	.0271
%E (Errors)	5.033	44		
Within	2.516	336		
B (Trials)	43.461	7	47.0839	.0000
AB	12.231	21	13.2501	.0000
%E (Errors)	.923	308		

Summary of (Instruction x Paradigm)

Analysis of Variance on Associative

Matching Recall of List 1 in

Experiment I

Source	MS	df	F	P
Total	11.346	95		
Between	53.811	7		
A (Instruction)	16.670	1	2.0922	.1479
B (Paradigms)	116.362	3	14.6041	.0000
AB	3.640	3	.4568	.7172
Within	7.968	88		

Summary of (C-NC x Instruction-Noninstruction x Paradigm)

Analysis of Variance on Total Trials

of List 2 in Experiment II

Source	MS	df	F	P
Total	9.696	143		
Between	36.204	11		
A (C-NC)	29.341	1	3.9190	.0469
B (Instruction)	55.008	1	7.3474	.0076
C (Paradigms)	115.715	2	15.4360	.0000
AB	18.062	1	2.4125	.1187
AC	19.923	2	2.6611	.0718
BC	1.717	2	.2293	.7981
ABC	10.563	2	1.4109	.2463
Within	7.487	132		

Summary of (C-NC x Instruction-Noninstruction x Paradigm)
Analysis of Variance on Total Errors
of List 2 in Experiment II

Source	MS	df	F	P
Total	62.500	143		
Between	233.733	11		
A (C-NC)	283.359	1	5.8750	.0159
B (Instruction)	728.359	1	15.1146	.0004
C (Paradigms)	616.964	2	12.7919	.0001
AB	12.252	1	.2540	.6212
AC	91.674	2	1.9007	.1514
BC	30.773	2	.6380	.5348
ABC	33.814	2	.7011	.5024
Within	48.231	132		

Summary of (C-NC x Instruction-Noninstruction x Paradigm)

Analysis of Variance on Percentage of Transfer

for Total Errors on List 2 in Experiment II

Source	MS	df	F	P
Total	2047.718	143		
Between	7450.500	11		
A (C-NC)	10707.750	1	6.7029	.0104
B (Instruction)	15820.500	1	9.9034	.0024
C (Paradigms)	22157.254	2	13.8701	.0000
AB	2997.004	1	1.8761	.1696
AC	2415.377	2	1.5120	.2227
BC	807.002	2	.5052	.6103
ABC	835.490	2	.5230	.5996
Within	1597.486	132		

Summary of (C-NC x Instruction-Noninstruction x Paradigm)

Analysis of Variance on Errors Across 1-8 Trials on

List 2 for Instructed subjects in Experiment II

Source	MS	df	F	P
Total	3.065	287		
Between	4.793	35		
A (Paradigms)	18.063	1	4.1029	.0480
%E (Errors)	4.403	34		
Within	2.825	252		
B (Trials)	36.892	7	79.5892	.0000
AB	32.741	7	70.6342	.0000
%E (Errors)	.464	238		

Summary of (C-NC x Instruction-Noninstruction x Paradigm)

Analysis of Variance on Errors Across 1-8 Trials on

List 2 for Noninstructed Subjects in Experiment II

Source	MS	df	F	P
Total	3.727	287		
Between	6.064	35		
A (Paradigms)	5.643	1	.9287	.6562
%E (Errors)	6.077	34		
Within	3.402	252		
B (Trials)	45.417	7	46.3822	.0000
AB	26.898	7	27.4699	.0000
%E (Errors)	.979	238		

Summary of (C-NC x Instruction-Noninstruction x Paradigm)

Analysis of Variance on Associative Matching

Recall in List 1 in Experiment II

Source	MS	df	F	P
Total	13.154	143		
Between	54.606	11		
A (C-NC)	393.360	1	40.5547	.0000
B (Instruction)	.249	1	.0257	.8674
C (Paradigms)	1.187	2	.1223	.8848
AB	11.112	1	1.1457	.2863
AC	69.464	2	7.1616	.0015
BC	14.149	2	1.4587	.2348
ABC	13.172	2	1.3580	.2597
Within	9.699	132		