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FUNCTIONAL VERSUS NOMINAL FREQUENCY RULES IN

MULTIPLE-ITEM RECOGNITION MEMORY

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TABLE OF CONTENTS

LIST OF TABLES

Abstract

The existing literature pertaining to the W_1-R_2 verbal discrimination transfer paradigm was reviewed. A trend in the literature indicated that overlearning constitutes a source of negative transfer in that paradigm. Two distinct hypotheses concerning the mechanism underlying the decremental effect of overlearning were evaluated in the current experiment. A response set hypothesis predicted that if a nominal Rule 1 (Rule 2) frequency differential predominated among the first-list pairs, then overlearning would induce functional Rule 1 (Rule 2) frequency behavior which would produce decrements (increments) in transfer when a nominal Rule 2 frequency differential predominated among the second-list pairs, as in the W_1-R_2 paradigm. An incidental associative interference hypothesis predicted that overlearning would tend to produce a decrement in transfer by strengthening incidentally learned intrapair associations, regardless of which type of frequency differential predominated among the first-list pairs. The results were interpreted as being in strong support of the response set hypothesis. Both the incremental and the decremental transfer effects predicted by that hypothesis were observed.

Functional Versus Nominal Frequency Rules In

Multiple-Item Recognition Memory

The verbal discrimination transfer paradigm in which List 2 is composed of the wrong (W) items from List 1 paired with new right (R) items (hereafter designated as the W_1-R_2 paradigm) is of historical importance to the frequency theory of verbal discrimination learning (Ekstrand, Wallace, & Underwood, 1966). When a short anticipation interval (1.5 sec) was employed, Underwood, Jesse, and Ekstrand (1964) observed that the W_1-R_2 paradigm yielded pronounced positive transfer early in List 2 learning followed by negative transfer later in learning, relative to a nonspecific transfer control in which List 2 was composed of both new W items and new R items (the W_2-R_2 paradigm). That pattern of transfer effects provided the major impetus for Underwood et al. (1964) to include in the post hoc explanation of their results some hypothesized mechanisms whereby frequency units accrue at differential rates to W and R items during List 2 learning. In order to accomodate the transfer data from the W_1-R_2 paradigm, those mechanisms were required to supplement their more fundamental assumption that discriminations between W and R items were based on differential frequency cues.

In the formal statement of frequency theory, Ekstrand et al. (1966) further elucidated the mechanisms of frequency unit accrual (i.e., representational responses, pronunciation responses, rehearsals of the right items, and implicit associative responses), and they postulated that the combined effect of those mechanisms resulted in at least a 2:1 frequency differential in favor of the right items. The theory was put forth as an extension of the post hoc explanation of the Underwood et al. (1964) transfer study in that it proposed that frequency was also the discriminative cue underlying single-list verbal discrimination learning.

In view of the above chain of events, their chronological order, and the rôle that was played by the W_1-R_2 paradigm, one would expect the data generated by that paradigm to generally be in consonance with the tenets of frequency theory (Ekstrand et al., 1966). However, a review of the literature indicates that expectation has not been met (cf., Eckert & Kanak, 1974). The concern of the present paper is primarily limited to the conspicuous lack of support for frequency theory's prediction of positive transfer early in List 2 learning for the W_1-R_2 paradigm. The majority of the extant data characteristically evidences negative transfer beginning on the first or second trial of List 2 learning regardless of whether mixed lists (Kausler & Dean , 1967; McClelland, 1942) or unmixed lists (Eschenbrenner, 1969; Kanak & Dean, Experiment I, 1969; Kanak & Rabenou, 1975; Kausler, Fulkerson, & Eschenbrenner, 1967) are employed.

Underwood et al. (1964) reconciled their finding of initial positive transfer with McClelland's (1942) finding of negative transfer on the first trial by noting that McClelland had employed mixed lists and that his subjects had not been informed of the relationship between List 1 and List 2. Subsequently, other investigators (e.g., Kanak & Dean, 1969; Kausler & Dean, 1967; Kausler et al., 1967) have argued that the failure of Underwood et al. to observe initial negative transfer was due to their subjects having been fully informed concerning the interlist relationship. Furthermore, it has been suggested that initial negative transfer should obtain in the absence of such information due to the positive transfer effects predicted by frequency theory being outweighed by detrimental effects of associative interference from intrapair associations incidentally acquired during List 1 learning (Kanak & Dean, 1969; Kausler et al., 1967).

The proposition that negative transfer is masked in the presence of information concerning interlist relationships appears to have been borne out by experiments employing mixed lists. McClelland (1942) found performance on W_1-R_2 pairs to be significantly below chance on the first transfer trial, and Kausler and Dean (1967) found performance on W_1-R_2 pairs to fall below that on W_2-R_2 pairs beginning on the second transfer trial. Subjects were not informed of the interlist relationships in either of those studies. Lovelace (1966) informed his subjects of the interlist relationships and found performance on W_1-R_2 pairs to be above chance on the first trial. Performance continued to be above chance across three subsequent test trials even though no feedback was given during List 2 presentation. However, any conclusions drawn on the basis of the combined results of these three studies should be viewed with caution. Paul and Paul (1968) have suggested that mixed-list procedures are particularly suited for detecting interpair effects attributable to conceptually-based response sets. Such response sets are conceived to be induced by the presence of one or more subsets of list pairs each of which is defined on the basis of a shared intrapair relationship among its elements. The response set induced by one subset of the list items in a mixed list may serve to either facilitate or degrade performance on another subset. The latter effect has been rather dramatically demonstrated by C. Paul and his associates in the case of verbal discrimination reversal learning (Paul, 1966; Paul, 1968; Paul, Callahan, Mereness, & Wilhelm, 1968). Increases in the percentage of items reversed were found to be accompanied by increases in the number of errors made on nonreversed items. When the majority of the items (75%) were reversed, subjects appeared to be responding to the nonreversed items as if they, too, had been reversed. Due to the obvious complexity of the mixed-list situation, the concern of the present study is with unmixed-list procedures.

An orderly relationship between the presence or absence of information and the sign or magnitude of initial transfer in the W_1-R_2 paradigm fails to emerge in the literature pertaining to the unmixed-list situation. King and Levin (1971), with two notable exceptions, employed procedures identical to those used for the groups receiving the short anticipation interval (1.5 sec) in the Underwood et al. (1964) study. The exceptions were that their subjects received no information and that they manipulated the number of List 1 learning trials (2, 4, or 8). Subjects in the Underwood et al. study had been fully informed, and List 1 learning had been carried to a criterion of three successive perfect trials ($\overline{X}$=9.42 trials). Thus, if it is assumed that the group receiving eight trials of List 1 learning in the King and Levin study is comparable to the group run by Underwood et al., those groups differed only with respect to the information variable. However, King and Levin observed positive transfer for the W_1-R_2 paradigm across the first five trials of List 2 learning, even though their subjects had not been informed of the interlist relationship. Furthermore, it should be noted that King and Levin failed to observe the significant negative transfer later in learning that was reported by Underwood et al. Thus, if anything, the information given in the Underwood et al. study may have served to increase negative transfer rather than mask it.

Although findings of initial positive transfer strongly support frequency theory, they have previously been singled out as being atypical. Thus the effects of information in unmixed-list studies finding initial negative transfer should be of more logical concern. The proposition that negative transfer, when it obtains, is attributable to incidental associative interference (Kanak & Dean, 1969; Kausler et al., 1967) is strongly supported by the fact that studies yielding such transfer have all employed high frequency (meaningful) stimuli (Eschenbrenner, 1969; Kanak & Dean, Experiment I, 1969; Kanak & Rabenou, 1975), whereas the studies finding initial positive transfer employed low frequency (less meaningful) stimuli (King & Levin, 1971; Underwood et al., 1964). Subjects were given no information concerning the interlist relationship in any of the studies cited in the previous sentence as having found initial negative transfer. In one of those studies (Eschenbrenner, 1969) the lists employed were taken from a previous experiment by Kausler et al. (1967). This is noteworthy in that Kausler et al. failed to find evidence for significant negative transfer. Although there were other methodological differences between the Kausler et al. study and Eschenbrenner's, it is of interest to note that subjects in the former study were quasi-informed in that they were told that there might be "some" (unspecified) relationship between List 1 and List 2. Thus, it is tempting to conclude that information does reduce negative transfer when high frequency stimuli are employed. However, that conclusion would conflict with the apparent tendency for information to increase negative transfer when low frequency stimuli are employed (i.e., King & Levin, 1971 vs. Underwood et al., 1964). Therefore, another explanation for the failure of Kausler et al. to observe significant negative transfer was sought. It was noted that while Eschenbrenner (1969), Kanak and Dean (Experiment I, 1969), and Kanak and Rabenou (1975) had carried List 1 learning to a criterion of two successive perfect trials, Kausler et al. had employed a less stringent criterion of one perfect trial. This suggests that degree of learning was the relevant variable, rather than information. A re-evaluation of the evidence from studies employing low frequency stimuli indicated that in that case, also, the study requiring the lesser degree of List 1 learning (King & Levin, 1971) yielded the least evidence for negative transfer. The notion that high degrees of List 1 learning can produce decrements in transfer for the W_1-R_2 paradigm provides the point of departure for the current research.

Given that the present study could demonstrate high degrees of List 1 learning (overlearning) to be a source of negative transfer in the W_1-R_2 paradigm, the eminent question would become through what mechanism(s) does overlearning on List 1 produce negative transfer? It could be that overlearning on List 1 strengthens the incidentally learned intrapair associations postulated by Kanak and Dean (1969) and by Kausler et al. (1967), thereby further outweighing the positive transfer effects predicted by frequency theory. However, a more intriguing possibility is that overlearning on List 1 induces a response set that is carried over into the List 2 situation and interferes with acquisition.

This proposition is akin to Paul and Paul's (1968) analysis of the processes operating in mixed-list situations, with the exception that they conceive response sets to be "activated" by the onset of List 2 rather than during List 1 learning. A potential basis for such an interfering response set suggests itself if one entertains the possibility that the nominal frequency "rules" outlined by Ekstrand et al. (1966) can become functional during overlearning. Those authors employed the term Rule 1 to describe the nature of the frequency differential that obtained if the R item in a given pair was also the most frequent and the term Rule 2 if the R item was the least frequent. They qualified their use of the term rule as being meant merely to denote the frequency differential for individual pairs and not being meant to connote the conscious application of a conceptual strategy on a list-wide basis. Upon mastery of List 1 (e.g., one perfect trial), Ekstrand et al. postulated that a Rule 1 frequency differential predominated among the pairs in the list. By the same logic, overlearning on List 1 should further serve to insure that a Rule 1 frequency differential exists within each of the pairs. It is herein deemed possible, if not plausible, that the exclusive dominance of Rule 1 frequency differentials produced by overlearning induces a response set (functional rule) to emit the most frequent item in each pair. Such a response set would be expected to interfere with List 2 acquisition in the W_1-R_2 paradigm since, at least on the initial trials, a Rule 2 frequency differential predominates among the pairs (i.e., the W item is the most frequent).

The current study was designed in an attempt to decide between the hypothesis of increased incidental associative interference and the hypothesis of an induced interfering response set as explanations for decrements in transfer due to overlearning in the W_1-R_2 paradigm. The response set hypothesis predicts that if Rule 2 was predominant among the List 1 pairs, then the response set induced by overlearning (emit the least frequent response) should produce an increment in transfer for the W_1-R_2 paradigm, rather than a decrement. However, the incidental associative interference hypothesis predicts a decrement in transfer due to overlearning, regardless of whether Rule 1 or Rule 2 predominated among the List 1 pairs. In the present experiment, List 1 was constructed either of W and R items that were homogeneous (high) with respect to normative familiarity (the classical situation in which Rule 1 should predominate with respect to situational frequency) or of high familarity W items and low familiarity R items (a contrived situation in which Rule 2 predominates, by construction, with respect to normative frequency). The logic employed in deriving predictions from the response set hypothesis implicitly assumes that subjects have not been provided with a conceptual strategy that would override response set effects. In view of this fact, the information variable was also manipulated in the present study.

Method

Design. The basic experimental conditions conformed to a 2 x 2 x 2 x 2 factorial, between groups, design. The factors correspond to paradigm (W_1-R_2 vs. W_2-R_2), degree of List 1 learning (overlearning vs. no overlearning), predominant List 1 rule (Rule 1 vs. Rule 2), and information concerning the interlist relationship (informed vs. uninformed).

Lists. The stimuli were 96 nouns selected from an advance copy of the Colorado Concreteness and Imagery Norms (Note 1) which had been augmented to include familiarity and meaningfulness ratings (7-point scales). Six 16-word lists were compiled, and every effort was made to effect the following constraints: (1) semantic and phonetic relationships were minimal both between and within lists, (2) the instance of words within a list sharing the same first letter was minimal, and (3) word length was balanced between lists. One of those lists was constructed to be of low familiarity items ($\bar{X}$=4.25, S.D.=0.28), and the other five lists were constructed to be of high(er) familiarity items ($\bar{X}$s=5.30-5.35, S.D.s=0.14-0.24). Both the imagery ($\bar{X}$=4.48, S.D.=0.62) and the meaningfulness ($\bar{X}$=3.54, S.D.=0.32) values for the low familiarity list were approximately equated with those for the high familiarity lists ($\bar{X}$s=4.65-4.73, S.D.s=0.55-0.74 for imagery; $\bar{X}$s=3.65-3.72, S.D.s=0.23-0.34 for meaningfulness). For convenience of reference, the low familiarity list will be labeled as L1 and the high familiarity lists as H1, H2, H3, H4, and H5.

The words in H1 were paired quasi randomly with the words in H2 to form List 2. This and all subsequent pairing procedures were subject to the restriction that there be no first-letter overlap or obvious semantic relationship between the words in a pair. The word from H1 was designated as the W item in each pair. Thus, in consistence with the W-R notation, the sixteen List 2 pairs may be designated as being of the form H1-H2 (i.e., the left-hand member is the W item).

Since all subjects were to receive the same second list, the four Paradigm x Rule treatment combinations were defined on the basis of the relationship that List 1 bore to List 2 and on the basis of the familiarity of the W items relative to the R items within List 1. The construction of the lists for the W_1-R_2 paradigm will be discussed first. Following the logic outlined in the last paragraph of the introduction, the sixteen first-list pairs for the Rule 1 condition were of the form H1-H3 and for the Rule 2 condition of the form H1-L1. The corresponding first-list pairs for the W_2-R_2 paradigm were of the form H4-H3 and H4-L1, respectively. The specific pairings in these four lists (H1-H3, H1-L1, H4-H3, and H4-L1) were not assigned on a random basis. In order to effect a homogeneous within-pair familiarity differential for each set of List 1 pairs, an attempt was made to pair the highest familiarity W item with the highest familiarity R item, the lowest with the lowest, etc. Some deviations from this procedure were necessitated by the previously outlined pairing restrictions, but the goal of homogeneity appeared to have been achieved in that the standard deviation of the within-pair familiarity differences never exceeded 0.15 for any set of List 1 pairs employed in the experiment.

The H1 and H2 items were then subjected to a second quasi random pairing and a reversal of wrong-right item function. The resulting pairs were of the form H2-H1 and constituted a second List 2, which provided the basis for a replication of each of the List 1 conditions. The new sets of List 1 pairs were constructed in the same manner as the first sets had been constructed. The resulting sets of pairs were of the forms H2-H3, H2-L1, H5-H3, and H5-L1 replicating H1-H3, H1-L1, H4-H3, and H4-L1, respectively. It should be emphasized at this point that all subjects in this second replication received H2-H1 as List 2, whereas all subjects in the first replication received H1-H2 as List 2.

As a final note on list attributes, it should be reported that the mean within-pair familiarity differentials for the Rule 1 first lists ranged from 0.02 to 0.05 and for the Rule 2 first lists from 1.06 to 1.09. It was previously mentioned that the standard deviation of those frequency differentials never exceeded 0.15 in the first list (S.D.s=0.03-0.15). The frequency differentials for the two replications of List 2 were identical ($\bar{X}$=0.01, S.D.=0.20).

Four quasi random serial orders were constructed for each of the ten previously described 16-pair lists. The following restrictions were imposed: (1) the left-right spatial position of the W and R items had to be balanced across orders for each pair, (2) no more than three items with the same function (W or R) could occur in the same spatial position in consecutive serial order, and (3) the last two pairs of a given serial order could not be among the first two pairs of the successive order.

Procedure. The pairs were presented by the anticipation method at a 2:2 sec rate via a Lafayette memory drum. The words were presented in horizontal juxtaposition during the anticipation interval, and the subjects' task was to pronounce the word believed to be the R item before the onset of the feedback interval. During the feedback interval, the words were presented again in their original positions with the R item underlined. A set of asterisks appeared in lieu of a pair during the 2-sec intertrial intervals.

Prior to List 1 learning, all subjects received the same relatively standard verbal discrimination instructions and two practice trials on a 4-pair list of female and male first names. The instructions did not specify the criterion against which their List 1 performance would be evaluated. In this regard, the instructions read: "Even though you may have achieved several consecutive presentations of the list without making any errors, it is important that you continue doing your best until I inform you that the task has been completed." Subjects in the no overlearning conditions learned List 1 to a criterion of one errorless trial. Subsequent to meeting the criterion of one errorless trial, subjects in the overlearning conditions additionally received half again as many trials as it had taken them to reach that criterion (including the criterial trial). In the event that the indicated number of postcriterial trials was a fraction, it was rounded to the next higher whole number. There was no evident change in procedure to signal the transition from criterial to post-criterial trials. The List 1 instructions provided no indication of the fact that acquisition of a second list would be required. Prior to List 2 learning, subjects in all of the uninformed conditions were given the same instructions. They were simply told that they were being asked to learn a second list for which the procedure would be the same as it had been for learning the first list, and a brief reiteration of the List 1 instructions was given. Those instructions were supplemented with several additional sentences for the informed conditions. Subjects in the informed conditions who received the W_2-R_2 paradigm were additionally told (2 sentences) that the second list was "...composed of an entirely new set of items, bearing no particular relationship to those of the first list." Again relative to the uninformed conditions, subjects in the informed conditions who received the W_1-R_2 paradigm were additionally told (4 sentences) explicit information concerning the interlist relationship. That information included the fact that the List 1 W items were being carried over into List 2 and that the new R items had not appeared in List 1. Approximately 3 minutes passed between the termination of List 1 learning and the presentation of the first List 2 pair. Learning was carried to a criterion of one errorless trial on List 2 for all conditions. The first trial on both List 2 and List 1 was conducted as a guessing trial.

Subjects. The subjects were 192 undergraduates who participated in the experiment as an elective option among alternative requirements for students enrolled in introductory psychology courses at the University of Oklahoma. Subjects were run on an individual basis, in the order of their appearance, in accord with a blocked randomization procedure. Each block constituted a quasi random ordering of the 32 unique treatment combinations defined by crossing information and degree of learning with the two list replications nested in each of the Paradigm x Rule combinations. The only restriction imposed on the randomization was that each of the 16 basic experimental conditions from the design section be represented in each half of the block. Each of two experimenters ran three successive blocks of subjects, resulting in an N of 12 for each of the 16 cells in the design.

Results

The performance measures subjected to analysis in the present study were: trials to criterion, percent of transfer (cf., Read & Scarlett, 1973), errors on Trial 1, and errors on Trials 2-6. Since first-list learning differences might be expected on the basis of the rule manipulation, list (List 1 vs. List 2) was included as a factor in all analyses. The inclusion of the list factor also served a second purpose. Since the majority of the factors (i.e., paradigm, information, and degree of learning) were dummy variables within List 1, requiring each of those factors to interact with list before being considered significant provided a safeguard against basing conclusions concerning List 2 performance on effects attributable to sampling differences. Furthermore, since the focus of the present study is on transfer, factors that failed to interact with paradigm (W_1-R_2 vs. W_2-R_2) were viewed as being of ancillary interest. It was reasoned that the conjoint practical and theoretical concerns over interactions with the list and paradigm factors could be imposed on the data analyses by examining only those ANOVA sources that contained both of those factors. Consequently, in order for a main effect or an interaction effect to be considered of theoretical interest in the present study, it had to enter into a significant interaction with List x Paradigm. Almost without exception, only such effects will be reported here.

As might be expected, a number of relatively complex interactions were encountered in the subsequent analyses. To investigate the nature of such interactions, recourse was made to examining simpler interactions or main effects nested in combinations of the remaining variables. Whenever that procedure was used, the error term employed for testing those effects was derived on the basis of the pooling rules outlined by Kirk (1968) for testing simple effects. Those rules were followed without exception, as will be reflected in the degrees of freedom associated with each such test.

The acceptable level of significance was set at $p < .05$. Therefore, except in association with tests of simple effects, probability values will not be reported in the text. Lastly, whenever a mean is reported, it will be immediately followed by a standard deviation contained in parentheses.

Trials to criterion. The number of trials required to attain the criterion of one errorless trial (including the criterial trial) was tabulated for each subject on both lists. The resulting data was analyzed as a mixed and partially hierarchical 2 x 2 x 2 x 2 x 2 x 2 x 2 factorial design. The only within subjects variable was list. The between subjects variables were: experimenter, paradigm, degree of learning, rule, and information. The replication variable was nested in Paradigm x Rule treatment combinations.

The List x Paradigm interaction was significant, $F(1,128) = 23.09$, $MSe = 7.45$. On List 1, the mean number of trials required to reach criterion was 6.64 (2.93) for the W_2-R_2 group and 7.71 (3.89) for the W_1-R_2 group. The corresponding means on List 2 were 5.51 (2.59) and 3.91 (2.61). The simple effect of paradigm was significant on both List 1 and List 2, $Fs(1,256) = 5.99$ and 13.40, $ps < .02$ and .001, respectively, $MSe = 9.22$. Since the experiment was designed to detect complex interactions, the significant effect of paradigm within List 1 might well be ascribed to an over-powered test (i.e., 96 observations per cell). In any case, the sampling differences present in List 1 were reversed in List 2, indicating that positive transfer obtained for the W_1-R_2 paradigm relative to the W_2-R_2 control.

The other factors and their interactions failed to enter into any significant interactions with the List x Paradigm source. Thus, the trials to criterion measure proved to be insensitive to the presence of any effects on transfer that could be attributed to the variables of interest. To check for effects of experimenter and replication, the requirement that they interact with List x Paradigm was relaxed. Since none of the 48 sources involving experimenter or replication were found to be significant, those factors were not included in subsequent analyses.

Percent of transfer. The number of errors that were committed prior to attaining the criterion of one errorless trial was tabulated for each subject on both lists. For each List x Degree of Learning x Rule x Information condition, each W_1-R_2 subject's score was converted to percent of transfer by: (1) subtracting the subject's score from the mean of the associated W_2-R_2 group, (2) dividing that difference by the sum of the subject's score and the W_2-R_2 group mean, and (3) multiplying that quotient by 100. Although those computational procedures are well-defined for the List 1 scores, some readers may object that there is no such thing as transfer within List 1. That is, indeed, the case. Admittedly, if there are no sampling differences in List 1, the mean for the measure should be zero. However, in the presence of sampling differences, that need not be the case. As before, List 1 data was included as part of a safeguard against basing conclusions concerning List 2 performance on effects attributable to sampling differences.

The percent of transfer scores for the W_1-R_2 subjects were analyzed as a mixed 2 x 2 x 2 x 2 factorial design. The within subjects variable was list, and the between subjects variables were degree of learning, rule, and information. Since the paradigm variable is absent in percent of transfer data, the self-imposed criterion for the theoretical significance of a source was revised to be that it enter into a significant interaction with the list variable, rather than with List x Paradigm.

The main effect of list was significant, $F(1,88) = 107.71$, $MSe = 981.92$. The mean was -1.13 (25.47) for List 1 (i.e., essentially zero) and 45.81 (40.99) for List 2. The list variable entered into first order interactions with both information and rule, $Fs(1,88) = 8.12$ and 4.26, respectively, $MSe = 981.92$. The simple effect of information was not significant within List 1, $F(1,176) = 31.28$, $p < .001$, $MSe = 954.36$. On List 1, the means for the uninformed and the informed groups were -5.87 (24.92) and 3.62 (25.13), respectively. The corresponding means on List 2 were 28.18 (36.08) and 63.45 (37.91). Likewise, the simple effect of rule was not significant within List 1, $F<1$, but it was significant within List 2, $F(1,176)=6.49$, $p < .02$, $MSe = 954.36$. On List 1, the means for the Rule 1 and the Rule 2 groups were -2.43 (24.54) and 0.18 (26.31), respectively. The corresponding means on List 2 were 53.85 (35.53) and 37.78 (44.38). Thus, the effects of both information and rule were localized within List 2, indicating that they both affect transfer. The receipt of information concerning the inter-list relationship increased transfer relative to the uninformed condition. However, a similarly simplex description of the effects of the rule variable would be rendered premature in view of the next effect to be reported.

With respect to evaluating the competing experimental hypotheses, the most interesting effect to come out of this analysis was a significant List x Degree of Learning x Rule interaction, $F(1,88)=4.69$, $MSe = 981.92$. The interaction means are presented in Table 1. The simple effect of

Insert Table 1 about here

degree of learning was not significant within List 1 for either the Rule 1 or the Rule 2 groups, Fs<1. However, within List 2, the simple effect of degree of learning was significant for both the Rule 1 and the Rule 2 groups, $Fs(1,176)=5.09$ and 6.46, $ps < .03$ and $.02$, respectively, $MSe = 954.36$. Thus, the percent of transfer data strongly support the response set hypothesis. That is, as can be seen in the bottom half of Table 1, overlearning produced a decrement in transfer for the Rule 1 group and an increment in transfer for the Rule 2 group.

Errors on Trial 1. The number of errors exhibited on the first trial was tabulated for each subject on both lists. The resulting data was analyzed as a mixed 2 x 2 x 2 x 2 x 2 factorial design. The within subjects variable was list, and the between subjects variables were paradigm, degree of learning, rule, and information.

The List x Paradigm interaction was significant, $F(1,176) = 55.37$, $MSe = 5.22$. On List 1, the mean number of errors was 8.34 (2.39) for the W_2-R_2 group and 8.19 (2.15) for the W_1-R_2 group. The corresponding means on List 2 were 7.72 (1.84) and 4.09 (3.62). The simple effect of paradigm was not significant within List 1, $F<1$, but it was highly significant within List 2, $F(1,352)=108.04$, $p < .001$, $MSe = 5.84$.

A significant List x Paradigm x Information interaction, $F(1,176)=11.69$, $MSe = 5.22$, indicated that the amount of transfer for the W_1-R_2 paradigm varied as a function of information. Since the magnitude of positive (negative) transfer for a given W_1-R_2 group is measured by how many fewer (more) errors were made than in the associated W_2-R_2 group, the differences between the means for the associated W_1-R_2 and W_2-R_2 groups are displayed in Table 2, along with

Insert Table 2 about here

the interaction means. The Paradigm x Information interaction was highly significant within List 2, $F(1,352)=27.01$, $p < .001$, $MSe = 5.84$, but not within List 1, $F<1$. Within List 2, the simple effect of paradigm was significant for both the uninformed and the informed groups, $Fs(1,352) > 13.50$, $p < .001$, $MSe = 5.84$. Neither of those simple effects was significant within List 1, $Fs<1$. Thus, providing information served to increase positive transfer.

The significance of the List x Degree of Learning X Rule interaction in the percent of transfer data suggested that the corresponding interaction in the present analysis should be of particular interest. Since transfer must be evaluated relative to the W_2-R_2 control in the present analysis, the corresponding interaction is List x Paradigm x Degree of Learning x Rule. That source failed to meet the criterion for statistical significance, $F(1,176)=1.40$, $MSe = 5.22$. However, it was felt that this interaction deserved further examination. The interaction means are presented in Table 3. The Paradigm x Degree of Learning X

Insert Table 3 about here

Rule interaction was not significant within List 1, $F(1,352) = 1.81$, but it was significant within List 2, $F(1,352)=8.57$, $p < .01$, $MSe = 5.84$. Within List 2, the Paradigm x Degree of Learning interaction was significant for both the Rule 1 and the Rule 2 groups, $Fs(1,352)=4.11$

and 4.46, *ps* $< .05$ and .04, respectively, *MSe* = 5.84. Neither of those interactions was significant within List 1, *Fs*<1. Within List 2, the simple effect of paradigm was significant for each of the four combinations of rule and degree of learning, *Fs*(1,352)>12.00, *ps* $< .001$, *MSe* = 5.84. None of those simple effects were significant within List 1, *Fs*<1.90, *ps* $> .10$.

Thus, as can be seen in the bottom half of Table 3, the Trial 1 error data also supports the response set hypothesis. Positive transfer obtained for the W_1-R_2 groups regardless of whether they received overlearning and regardless of whether Rule 1 or Rule 2 predominated in List 1. However, overlearning produced a decrement in positive transfer for the Rule 1 group and an increment in positive transfer for the Rule 2 group.

Errors on Trials 2-6. The number of errors exhibited on each of those trials was tabulated for each subject on both lists. If the criterion of one errorless trial was met prior to Trial 6 on a given list, then subsequent trials were scored as zeroes for that list. The resulting data was analyzed as a mixed 2 x 2 x 2 x 2 x 2 x 5 factorial design. The two within subjects variables were list and trials, and the four between subjects variables were paradigm, degree of learning, rule, and information.

The List x Paradigm interaction was significant, *F*(1,176) = 30.67, *MSe*=10.47. On List 1, the mean total errors on Trials 2-6 was 14.07 (8.96) for the W_2-R_2 group and 16.70 (9.25) for the W_1-R_2 group. The corresponding means on List 2 were 10.66 (6.34) and 5.10 (6.51). The simple effect of paradigm was significant on both List 1 and List 2,

$\underline{F}s(1,352)=5.21$ and 23.32, $\underline{p}s < .03$ and .001, respectively, $\underline{MSe}=12.69$. Thus, it would appear that the sampling differences present in List 1 were reversed in List 2, indicating that positive transfer obtained for the W_1-R_2 paradigm relative to the W_2-R_2 control. However, it should be emphasized that the List x Paradigm interaction is reported here in deference to its assigned role in defining the theoretical significance of other sources. Any conclusions (or reservations) based on that interaction are premature in that each of the remaining effects to be reported constitutes a complex interaction with List x Paradigm. (The reader will subsequently note that no List 1 differences were observed when the nature of those complex interactions was investigated.)

A significant List x Paradigm x Trials interaction, $\underline{F}(4,704) = 22.47$, $\underline{MSe}=1.65$, indicated that the amount of transfer for the W_1-R_2 paradigm varied as a function of trials. However, that effect was further modified by the information variable. The means for the significant List x Paradigm x Information x Trials interaction, $\underline{F}(4,704)= 2.65$, $\underline{MSe}=1.65$, are presented in Table 4. Within List 2, the Information

Insert Table 4 about here

x Trials interaction was not significant for the W_2-R_2 groups, $\underline{F}<1$, but it was highly significant for the W_1-R_2 groups, $\underline{F}(4,1408)=6.99$, $\underline{p} < .001$, $\underline{MSe}=1.72$. Neither of those interactions was significant within List 1, $\underline{F}s<1$. The differences between the means for the corresponding informed and uninformed conditions are also displayed in Table 4. On the basis of those values, it can be seen that there was essentially no effect of information across Trials 2-6 of List 2 for the W_2-R_2 groups. Thus, the baseline for evaluating transfer in the informed W_1-R_2 group was essentially the same as the baseline for evaluating transfer in the uninformed W_1-R_2 group. Consequently, the differences between the mean errors for the two W_1-R_2 groups served to index the effect that the information variable had with respect to the amount of transfer exhibited on each of the various trials. Those differences are displayed across the bottom of Table 4. They indicate that providing information increased positive transfer in the W_1-R_2 paradigm, and that the effect was strongest on Trials 2 and 3.

The highest order interaction (i.e., the six-way interaction) in the present analysis failed to reach the criterion for statistical significance, $F(4,704)=1.81$, $p > .12$, $MSe=1.65$. However, it was anticipated that floor effects would become evident on later trials in List 2 --- for instance, note the means on Trials 4, 5, and 6 for List 2 in Table 4. Therefore, a test was performed on the orthogonal component (Winer, 1971) of the six-way interaction that contrasted the List x Paradigm x Degree of Learning x Rule x Information interaction on early trials (2 and 3) with that on later trials (4, 5, and 6). The indicated List x Paradigm x Degree of Learning x Rule x Information x (Trials 2+3 vs. Trials 4+5+6) interaction was, indeed, significant, $F(1,704)=7.07$, $p < .01$, $MSe=1.65$. That orthogonal component accounted for 97.6% of the total variability attributable to the six-way interaction. In consideration of the extreme complexity of the implied interaction and the overwhelming number of cells involved, the primary focus will be on the transfer list data. Accordingly, only the List 2 means for the cells involved in the significant orthogonal component are presented in Table 5.

Insert Table 5 about here

In preparation for investigating the nature of the List X Paradigm X Degree of Learning X Rule x Information x (Trials 2+3 vs. Trials 4+5+6) interaction, the Paradigm x Degree of Learning x Rule interaction was computed for each of the twenty treatment combinations defined by crossing the list, information, and trial variables. The total sum of squares attributable to those twenty nested interactions was 78.41. The nested Paradigm x Degree of Learning x Rule interaction for the uninformed groups on Trial 2 of List 2 was pooled with that on Trial 3. That pooled source was significant, $\underline{F}(2,1760)=4.16$, $\underline{p} < .02$, $\underline{MSe}=3.91$, and it accounted for 41.5% of the total variability attributable to the nested interactions. Next, the nested interaction for the uninformed groups on Trial 4 of List 2 was pooled with that on Trial 5 and on Trial 6. Although that source accounted for an additional 23.7% of the total variability attributable to the nested interactions, it failed to reach the criterion for statistical significance, $\underline{F}(3,1760)=1.58$, $\underline{p} > .19$, $\underline{MSe}=3.91$. Neither of the corresponding pooled sources was significant for the informed groups, $\underline{F}s<1$. Lastly, an examination of the corresponding four pooled sources within List 1 failed to reveal any significant effects due to sampling differences, $\underline{F}s<1.10$.

In terms of transfer (the differences between corresponding W_1-R_2 and W_2-R_2 group means), it can be seen in Table 5 that the Degree of Learning x Rule interaction for the uninformed groups on early trials (2 and 3) is of the same form as that found in the analyses of the two previous measures. That is, overlearning produced a decrement in positive transfer for the Rule 1 group and an increment in positive transfer for the Rule 2 group when no information was provided concerning the interlist relationship. The solely significant pooled source attests to the reliability of that pattern as it is evidenced among the differences between the group means in the upper left-hand portion of Table 5. The Degree of Learning x Rule interaction for the uninformed groups on later trials (4, 5, and 6) is of the same form, but it was found to be statistically unreliable, perhaps due to the mitigating influence of floor effects. Within both early and later trials, providing information concerning the interlist relationship appeared to have the effect of nullifying the overlearning effect that obtained within each of the rule conditions.

Thus, the Trial 2-6 error data for the uninformed groups provides additional support for the response set hypothesis. The data from the informed groups indicates that overlearning effects may be attenuated by providing information concerning the interlist relationship. The latter finding is interpreted as providing support for the fundamental assumption that response sets underlie overlearning effects.

Discussion

Several characteristics of the data appear to warrant further attention prior to a discussion of the theoretical implications of the current findings. First, on the basis of each of the four performance measures, positive transfer was observed for the W_1-R_2 paradigm. Although various combinations of degree of learning, rule, and information affected the amount of transfer observed, the sign of that transfer was almost exclusively positive. Admittedly, this result is in contrast to the negative transfer observed in previous studies that have used unmixed lists of high frequency (meaningful) stimuli (Eschenbrenner, 1969; Kanak & Dean, Experiment I, 1969; Kanak & Rabenou, 1975). However, in an absolute sense, even the sets of high familiarity items employed in the current study were of only moderate familiarity ($\bar{X}$s=5.30-5.35, on a 7-point scale) and meaningfulness ($\bar{X}$s=3.65-3.72). Consequently, it would appear to be more appropriate to evaluate the current study relative to others that have employed low frequency (less meaningful) stimuli. Such studies (King & Levin, 1971; Underwood et al., 1964) have also shown evidence for positive transfer in the W_1-R_2 paradigm, and, thus, the positive transfer observed in the current study is not atypical. To be more explicit, it is suggested that the level of meaningfulness employed in the current study mitigated against the build-up of a degree of incidental associative interference (Kanak & Dean, 1969; Kausler, et al., 1967) sufficient to outweigh the positive transfer effects predicted by frequency theory (Ekstrand et al., 1966). That is not to suggest that the formation of incidental intrapair associations was precluded, but, rather, to suggest that their strength was attenuated.

The second notable characteristic of the data concerns the failure to observe any significant rule effects in List 1, despite the fact that rule was a first-list manipulation. As a post hoc attempt to detect first-list rule effects, the simple effect of rule was tested within List 1 for each of the following performance measures: trials to criterion, errors on Trial 1, and errors on Trials 2-6. The mean number of trials to criterion was 7.48 (3.52) for the Rule 1 group and 6.87 (3.43) for the Rule 2 group, but the observed trend toward superiority for the

Rule 2 group was not reliable, $F(1,352)=1.93$, $p > .16$, $MSe=9.40$. In terms of errors on Trial 1, the means were 7.71 (1.89) for Rule 1 and 8.82 (2.48) for Rule 2, $F(1,352)=10.21$, $p < .002$, $MSe=5.84$. However, that significant trend toward superiority for the Rule 1 group should be viewed with caution in that Trial 1 of the first list was truly a guessing trial. Lastly, the mean of the total errors on Trials 2-6 was 16.32 (8.48) for Rule 1 and 14.45 (9.79) for Rule 2, $F(1,352)=2.66$, $p > .10$, $MSe=12.69$. Apparently, the normative familiarity differentials ($\bar{X}s=1.06-1.09$) between the W and R items of the Rule 2 lists in the present study were not large enough to produce anything more than nonsignificant trends toward superiority for the Rule 2 group. Kausler and Farzanegan (1969), employing Rule 2 lists with much larger normative frequency differentials, also found evidence for functional frequency rule behavior during first-list acquisition. Pragmatically speaking, the absence of significant List 1 rule effects in the present study might be viewed as a fortunate state of affairs. That is, in the absence of List 1 rule effects, significant List 2 rule effects become all the more dramatic.

The third and final characteristic of the data to be noted is the apparent absence of List 2 information effects for the W_2-R_2 groups. The error data in Tables 2 and 4 indicates essentially identical performance for the informed and the uninformed W_2-R_2 groups across trials. In view of that fact, future designs might be made more efficient by halving the number of informed and uninformed W_2-R_2 subjects and then, in the absence of an information effect, pooling those groups to form a single W_2-R_2 control.

The results of the present study clearly demonstrate that when standard list construction procedures are employed (the Rule 1 group) overlearning on List 1 acts as a source of negative transfer in the W_1-R_2 paradigm. The decrement in transfer produced by overlearning in the Rule 1 group was predicted by each of two hypotheses: (1) overlearning on List 1 strengthens incidentally learned intrapair associations, thereby increasing the incidental associative interference present during List 2 acquisition and (2) overlearning on List 1 induces a response set to emit the most frequent item in each pair, thereby interfering with the acquisition of List 2 in which the R items are the least frequent. Thus, both the incidental associative interfernece hypothesis and the response set hypothesis find support in the data from the Rule 1 group.

In expanded form, the response set hypothesis states that: "If a nominal Rule 1 (Rule 2) frequency differential predominates among the first-list pairs, then overlearning induces functional Rule 1 (Rule 2) frequency behavior. Functional Rule 1 (Rule 2) frequency behavior will interfere with (facilitate) the acquisition of second-list pairs if a nominal Rule 2 frequency differential predominates among them." Therefore, the response set hypothesis predicted an increment in transfer for the Rule 2 group in the present experiment. That prediction was strongly supported by the data. Conversely, the increment in transfer produced by overlearning for the Rule 2 group appears to be totally incompatible with the hypothesis that overlearning has its effect through increasing incidental associative interference. However, that does not imply that incidental associative interference is not an important source of negative transfer in the W_1-R_2 transfer paradigm (Kanak & Dean, Experiment I, 1969; Kausler et al., 1967). The present results merely indicate that particular source of negative transfer to be insufficient for explaining the effects of overlearning in that paradigm.

In view of the opposing effects of overlearning exhibited by the Rule 1 and Rule 2 groups, any explanations for the overlearning effects based on either increased incidental associative interference or reduced availability of discriminative cues are rendered untenable. The response set hypothesis appears to provide the only parsimonious explanation capable of encompassing both the incremental and decremental effects observed in the present study. It is also viewed as being consistent with the information effect observed in the error data from Trials 2 and 3. That is, providing the subject with a conceptual strategy in the form of information concerning the interlist relationship might well be expected to override the effect of response sets. The response set hypothesis has even broader implications if one is willing to append its expanded form with an untested corollary: "Functional Rule 1 (Rule 2) frequency behavior will facilitate (interfere with) the acquisition of second-list pairs if a nominal Rule 1 (Rule 2) frequency differential predominates among them."

The verbal discrimination transfer paradigm in which List 2 is composed of a new set of W items paired with the R items from List 1 (the W_2-R_1 paradigm) has also received a great deal of attention (cf., Eckert & Kanak, 1974). One phenomenon of long-standing concern has been that transfer in the W_2-R_1 paradigm is consistently greater than transfer in the W_1-R_2 paradigm (e.g., McClelland, 1942; Underwood et al., 1964). Standard list construction procedures (no normative frequency differential between W and R items) were employed in each study that included such comparisons between the two paradigms. Thus, a nominal Rule 1 frequency differential would obtain among the pairs late in List 1 learning. If Rule 1 became functional prior to the onset of List 2, the corollary to the response set hypothesis predicts facilitation for W_2-R_1 acquisition (nominal Rule 1 pairs) and interference for W_1-R_2 acquisition (nominal Rule 2 pairs). Therefore the response set hypothesis is seen to have other potentially testable consequences.

As outlined in the introduction, the response sets proposed by Paul and Paul (1968) were conceived to be "activated" by the onset of the transfer list. In fact, they labeled them <u>Transfer-Activated Response Sets</u> (TARS). The response sets proposed in the present study are conceived to be activated during the acquisition of the initial list. Thus, in accord with the Pauls' labelling scheme, they might be aptly termed <u>Initial-Activated Response Sets</u> (IARS). Another potentially interesting line of research would be to study the interaction between IARS and TARS in a mixed-list context.

A final point, of separate theoretical interest, concerns the effect that the systematic variation of W and R item attributes had on the amount of transfer observed in the Rule 2 groups. It can be seen in the bottom, left-hand corner of Table 5 that there was no effect of overlearning in either the Rule 1 or Rule 2 group for the informed condition. However, the Rule 1 group exhibited consistently more transfer than the Rule 2 group. Apparently the Rule 2 group had fewer discriminative cues associated with the W items that were carried over from List 1. The possibility exists that in the presence of a pre-experimental basis for making List 1 discriminations, R items receive additional processing at the expense of W items. This interpretation is consistent with Kausler, Erber, and Olson's (1970) finding of a decrement in free-recall for W items following the acquisition of a list in which the R and W items could be discriminated on the basis of a taxonomic relationship among the R items. The decrement was measured relative to performance after the acquisition of a list in which all W and R items came from different taxonomic categories. That interpretation is also consistent with Kanak and Rabenou's (1975) finding of better retention of first-list associations after second-list learning for a group in which List 2 W items were of low imagery value and R items of high imagery value, relative to a group in which List 2 W and R items were homogeneous (low) with respect to imagery value.

Reference Note

1. *The Colorado concreteness and imagery norms*. (Report No. 10). Boulder: University of Colorado, Institute for the Study of Intellectual Behavior, July, 1973.

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TABLE 1

Means and Standard Deviations for Percent of Transfer as a Function of Rule, List, and Degree of Learning

	Rule 1		Rule 2	
	Mean	(S.D.)	Mean	(S.D.)
List 1				
No Overlearning	-2.38	(27.40)	-1.58	(25.63)
Overlearning	-2.48	(21.30)	1.94	(26.86)
List 2				
No Overlearning	63.90	(28.01)	26.45	(44.99)
Overlearning	43.79	(39.22)	49.11	(40.72)

TABLE 2

Means and Standard Deviations for Errors on Trial 1

as a Function of Information, List, and Paradigm

(Including Mean Within-Cell Paradigm Differences)

	Uninformed		Informed	
	Mean	(S.D.)	Mean	(S.D.)
List 1				
W_2-R_2	8.31	(2.34)	8.38	(2.45)
W_1-R_2	8.38	(1.84)	8.00	(2.40)
Difference	-0.07		0.38	
List 2				
W_2-R_2	7.73	(1.81)	7.71	(1.87)
W_1-R_2	5.92	(3.30)	2.27	(2.93)
Difference	1.81		5.44	

TABLE 3

Means and Standard Deviations for Errors on Trial 1 as a Function of Degree of Learning, List, Rule, and Paradigm (Including Mean Within-Cell Paradigm Differences)

	No Overlearning		Overlearning	
	Mean	(S.D.)	Mean	(S.D.)
List 1				
Rule 1				
W_2-R_2	7.71	(2.01)	7.54	(2.33)
W_1-R_2	7.42	(1.29)	8.17	(1.68)
Difference	0.29		-0.63	
Rule 2				
W_2-R_2	8.71	(2.35)	9.42	(2.36)
W_1-R_2	8.71	(2.32)	8.46	(2.77)
Difference	0.00		0.96	
List 2				
Rule 1				
W_2-R_2	7.96	(1.95)	7.38	(1.65)
W_1-R_2	3.17	(2.66)	4.58	(3.98)
Difference	4.79		2.80	
Rule 2				
W_2-R_2	7.29	(1.95)	8.25	(1.61)
W_1-R_2	4.88	(4.08)	3.75	(3.32)
Difference	2.41		4.50	

TABLE 4

Means and Standard Deviations for Errors on Trials 2-6 as a Function of List, Paradigm, and Information (Including Mean Within-Cell Information Differences)

	Trial 2		Trial 3		Trial 4		Trial 5		Trial 6	
	Mean	(S.D.)	Mean	(S.D.)	Mean	(S.D.)	Mean	(S.D.)	Mean	(S.D.)
List 1										
W_2-R_2										
Uninformed	4.85	(2.02)	3.56	(2.76)	1.98	(1.98)	1.27	(2.09)	0.85	(1.50)
Informed	5.35	(1.95)	4.13	(2.55)	2.90	(2.45)	1.92	(2.14)	1.33	(1.86)
Difference	-0.50		-0.57		-0.92		-0.65		-0.48	
W_1-R_2										
Uninformed	6.06	(2.17)	4.19	(2.67)	3.42	(2.56)	2.21	(2.22)	1.54	(1.97)
Informed	5.71	(2.03)	4.15	(2.56)	2.92	(2.25)	1.94	(2.07)	1.27	(1.56)
Difference	0.35		0.04		0.50		0.27		0.27	
List 2										
W_2-R_2										
Uninformed	5.25	(2.27)	2.85	(2.24)	1.40	(1.54)	0.81	(1.25)	0.60	(1.43)
Informed	5.17	(2.21)	2.69	(1.97)	1.42	(1.35)	0.77	(1.16)	0.35	(0.92)
Difference	0.08		0.16		-0.02		0.04		0.25	
W_1-R_2										
Uninformed	3.15	(2.89)	1.94	(1.95)	0.73	(0.99)	0.65	(1.20)	0.29	(0.76)
Informed	1.48	(2.27)	0.79	(1.51)	0.56	(1.12)	0.46	(1.32)	0.17	(0.75)
Difference	1.67		1.15		0.17		0.19		0.12	

TABLE 5

Means and Standard Deviations for Errors per Trial on List 2 across Trials 2-3 and across Trials 4-6 as a Function of Degree of Learning, Information, Rule, and Paradigm (Including Mean Within-Cell Paradigm Differences)

	Across Trials 2-3				Across Trials 4-6			
	No Overlearning		Overlearning		No Overlearning		Overlearning	
	Mean	(S.D.)	Mean	(S.D.)	Mean	(S.D.)	Mean	(S.D.)
Uninformed								
Rule 1								
W_2-R_2	4.88	(2.42)	4.13	(1.66)	1.14	(1.67)	0.72	(0.99)
W_1-R_2	2.21	(1.75)	3.04	(2.33)	0.36	(0.53)	0.33	(0.53)
Difference	2.67		1.09		0.78		0.39	
Rule 2								
W_2-R_2	3.71	(1.96)	3.50	(1.40)	0.61	(0.79)	1.28	(1.36)
W_1-R_2	3.42	(2.24)	1.50	(1.86)	1.19	(1.22)	0.33	(0.59)
Difference	0.29		2.00		-0.58		0.95	
Informed								
Rule 1								
W_2-R_2	3.96	(2.38)	4.25	(1.71)	0.81	(1.29)	0.75	(0.72)
W_1-R_2	0.33	(0.47)	0.88	(1.21)	0.00	(0.00)	0.14	(0.29)
Difference	3.63		3.37		0.81		0.61	
Rule 2								
W_2-R_2	3.63	(1.65)	3.88	(1.57)	0.94	(1.03)	0.89	(0.89)
W_1-R_2	1.54	(1.65)	1.79	(2.57)	0.81	(0.99)	0.64	(1.57)
Difference	2.09		2.09		0.13		0.25	

APPENDIX A

Practice List Pairs For All Conditions

Wrong	Right
JANE	BOB
RALPH	MARY
NANCY	FRED
TOM	SALLY

List 1 Pairs For Rule 1 W_2-R_2 Conditions

Replication 1		Replication 2	
Wrong	Right	Wrong	Right
AMBASSADOR	MOLECULE	DOUGH	SILK
DONOR	SILK	HEADBOARD	MOLECULE
KERNEL	UNREST	EMPIRE	KEROSENE
ENAMEL	TORTOISE	LARK	UNREST
HAIL	KEROSENE	BADGE	TORTOISE
MERCURY	VALIDATION	WIZARD	VALIDATION
SLUSH	DROPPER	GRIZZLY	DROPPER
FIGMENT	PETAL	PEER	LICE
COMPOSURE	LICE	OYSTER	PETAL
LARD	DISTORTION	FUSE	DISTORTION
WAFER	HEIR	MANOR	CUSTARD
VEIL	CUSTARD	ROOMER	HEIR
GNAT	ARMOR	COGNITION	ARMOR
PERJURY	CHUTE	SPOUT	RUDDER
RUBBLE	GASKET	ZENITH	CHUTE
TRIPOD	RUDDER	JARGON	GASKET

List 1 Pairs For Rule 1 W_1-R_2 Conditions

Replication 1		Replication 2	
Wrong	Right	Wrong	Right
INTEGRITY	SILK	FARE	SILK
RACQUET	MOLECULE	ROCKER	MOLECULE
LINT	UNREST	ISLE	UNREST
YOLK	KEROSENE	APATHY	KEROSENE
ADVERB	TORTOISE	HATCHET	TORTOISE
TRAPEZE	VALIDATION	SLIME	VALIDATION
HEXAGON	DROPPER	CINDER	DROPPER
GUTTER	PETAL	WATTS	PETAL
DERBY	LICE	EMERGENCE	LICE
BOAR	DISTORTION	LITER	DISTORTION
PODIUM	CUSTARD	BURLAP	CUSTARD
CEREBRUM	HEIR	MAHOGANY	HEIR
EMISSION	ARMOR	DIMPLE	ARMOR
SERF	CHUTE	VAULT	CHUTE
VALOR	RUDDER	TRANCE	RUDDER
MUTINY	GASKET	PANORAMA	GASKET

List 1 Pairs For Rule 2 W_2-R_2 Conditions

Replication 1		Replication 2	
Wrong	Right	Wrong	Right
DONOR	GAVEL	DOUGH	GAVEL
AMBASSADOR	TEMPEST	HEADBOARD	TEMPEST
KERNEL	SAPPHIRE	LARK	SAPPHIRE
ENAMEL	ABODE	WIZARD	ABODE
HAIL	MUTTON	BADGE	MUTTON
SLUSH	DETONATION	EMPIRE	DETONATION
MERCURY	LABYRINTH	PEER	LABYRINTH
FIGMENT	CLAMOR	GRIZZLY	CLAMOR
COMPOSURE	PYTHON	FUSE	PYTHON
LARD	BELLE	OYSTER	BELLE
WAFER	FOAL	ROOMER	FOAL
VEIL	RHAPSODY	MANOR	RHAPSODY
GNAT	VESTMENT	COGNITION	VESTMENT
PERJURY	MOSQUE	SPOUT	MOSQUE
RUBBLE	WAMPUM	ZENITH	WAMPUM
TRIPOD	HENCHMAN	JARGON	HENCHMAN

List 1 Pairs For Rule 2 W_1-R_2 Conditions

Replication 1		Replication 2	
Wrong	Right	Wrong	Right
LINT	GAVEL	FARE	GAVEL
INTEGRITY	TEMPEST	ROCKER	TEMPEST
RACQUET	SAPPHIRE	APATHY	SAPPHIRE
YOLK	ABODE	SLIME	ABODE
ADVERB	MUTTON	ISLE	MUTTON
TRAPEZE	DETONATION	HATCHET	DETONATION
GUTTER	LABYRINTH	CINDER	LABYRINTH
HEXAGON	CLAMOR	WATTS	CLAMOR
DERBY	PYTHON	LITER	PYTHON
PODIUM	BELLE	EMERGENCE	BELLE
BOAR	VESTMENT	BURLAP	FOAL
CEREBRUM	RHAPSODY	VAULT	RHAPSODY
EMISSION	FOAL	MAHOGANY	VESTMENT
SERF	MOSQUE	DIMPLE	MOSQUE
MUTINY	WAMPUM	PANORAMA	WAMPUM
VALOR	HENCHMAN	TRANCE	HENCHMAN

List 2 Pairs For All Conditions In a Given Replication

Replication 1		Replication 2	
Wrong	Right	Wrong	Right
LINT	VAULT	ISLE	LINT
INTEGRITY	TRANCE	HATCHET	INTEGRITY
RACQUET	EMERGENCE	PANORAMA	RACQUET
YOLK	CINDER	LITER	YOLK
ADVERB	LITER	ROCKER	ADVERB
TRAPEZE	HATCHET	APATHY	TRAPEZE
GUTTER	FARE	DIMPLE	GUTTER
HEXAGON	ISLE	BURLAP	HEXAGON
DERBY	ROCKER	VAULT	DERBY
PODIUM	SLIME	FARE	PODIUM
BOAR	WATTS	CINDER	BOAR
CEREBRUM	BURLAP	EMERGENCE	CEREBRUM
EMISSION	APATHY	TRANCE	EMISSION
SERF	MAHOGANY	MAHOGANY	SERF
MUTINY	PANORAMA	WATTS	MUTINY
VALOR	DIMPLE	SLIME	VALOR

APPENDIX B

INSTRUCTIONS

List 1 for all groups

Pairs of words will appear in the window of the memory drum positioned directly in front of you. One of the words in each pair has been arbitrarily designated as "correct" and the other as "incorrect". 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 aloud the "correct" word during the first exposure of the pair. During the second exposure, the "correct" word will be underlined to inform you as to whether or not you selected the appropriate word. Please do not make any overt verbal response while the pair with the underlining is in the window, simply take note of whether you selected the "correct" word or the "incorrect" word.

There are sixteen pairs of words in the list. Four different orders of the same list will appear, so that the position of any given pair within the list will vary from one presentation of the list to another. For example, the third pair that you see during the first presentation of the list may be the eleventh pair that you will see during the second presentation of the list. In addition, sometimes the "correct" word in a given pair will be the left-hand member of the pair and sometimes it will be the right-hand member of the pair. For example, the first time that a given pair is presented the "correct" word might be the left-hand member of the pair. But during the second presentation of that same pair, the words may be written in reverse order so that the "correct" word is now the right-hand member of the pair. Therefore, in view of the previous two facts, you should not try to use the position of the pair in the list or the left-right position of the "correct" word within the pair as aids in attempting to learn the pairs. Neither of those two things can help you. Any attempt to use them will only serve to hinder your learning of the pairs.

Needless to say, the first time that the list is presented you won't have any idea as to which word is the "correct" word in any of the pairs. However, for experimental reasons it is of extreme importance that you respond to each pair during every presentation of the list, including the first. Therefore, during the first presentation of the list you are asked to guess which word in each pair is the "correct" word. Immediately after you have made your guess out loud, the pair will appear again with the "correct" word underlined. That will be the procedure throughout your learning of the list following the initial guessing trial.

Each presentation of the list begins and ends with a set of stars being presented in the window. The stars will remain in the window for two seconds (during which time you are to remain silent) and then a new presentation of the list will begin, and you should begin responding as before. Please perform to the best of your ability every time the list is presented. Even though you may have achieved several consecutive presentations of the list without making any errors, it is important that you continue doing your best until I inform you that the task has been completed. Before going on to the actual experiment, you are going to be presented with a practice list. The practice list only contains four pairs, rather than sixteen. The purpose of the practice list is simply to help you get used to the procedure outlined in these instructions. REMEMBER: During the first exposure of each pair you are to respond aloud with only one word --- the one you believe is the "correct" word. During the second exposure of each pair you are to remain silent and take note of whether or not you selected the appropriate word. Lastly, remember to respond to each pair, beginning with the first pair that you see ... even if you have to guess.

Do you have any questions? If not, the practice list will now be presented.

One last note before we go on to the actual experiment, some of the words that you are about to see may not be as simple as BOB, MARY, and FRED. However, you are not going to be scored on your pronunciation. If you are uncertain about the pronunciation of some word, just pronounce it as best you can. There is no reason to feel self-conscious about it since the only thing that matters is that you pronounce aloud what you believe is the "correct" word in each pair. It doesn't matter how well you pronounce it, just that it is understandable to me.

Now we will begin the actual experiment. Remember to respond to each pair beginning with the first pair that you see. Ready? Begin.

List 2 instructions for all uninformed groups

I would now like you to learn a second list of sixteen word-pairs.

The procedure for learning this list is identical to the one that you used for the first list. As before, the list will be presented over and over again until I inform you that the task has been completed. Once again, it is important that you perform to the best of your ability every time that the list is presented. Also, recall that it is of extreme importance that you respond to each pair during every presentation of the list. Be sure to respond to every pair, beginning with the first pair that you see. Ready? Begin.

List 2 instructions for all informed W_2-R_2 groups

I would now like you to learn a second list of sixteen word-pairs.

The procedure for learning this list is identical to the one that you used for the first list. However, none of the words that were used in the pairs of the first list will appear anywhere in the list that you are about to learn. It is composed of an entirely new set of items, bearing no particular relationship to those of the first list. As before, the list will be presented over and over again until I inform you that the task has been completed. Once again, it is important that you perform to the best of your ability every time the list is presented. Also, recall that it is of extreme importance that you respond to each pair during every presentation of the list. Be sure to respond to every pair, beginning with the first pair that you see. Ready? Begin.

List 2 instructions for all informed W_1-R_2 groups

I would now like you to learn a second list of sixteen word-pairs.

The procedure for learning this list is identical to the one that you used for the first list. Furthermore, half of the words that were used in the pairs of the first list will also appear in the list that you are about to learn. To be more specific, the words which have been designated as "incorrect" in this list are exactly the same words which were designated as "incorrect" in the first list. However, the words which were designated as "correct" in the first list have each been replaced with an entirely new word. None of the new "correct" words appeared anywhere in the first list. As before, the list will be presented over and over again until I inform you that the task has been completed. Once again, it is important that you perform to the best of your ability every time that the list is presented. Also, recall that it is of extreme importance that you respond to each pair during every presentation of the list. Be sure to respond to every pair, beginning with the first pair that you see. Ready? Begin.

APPENDIX C

Summary Table for Analysis of Variance

Performed on Trials to Criterion

Source	df	MS	F
P (Paradigm)	1	6.7734	0.6166
R (Rule)	1	0.0234	0.0021
I (Information)	1	2.1901	0.1994
D (Degree of Learning)	1	11.6901	1.0642
E (Experimenter)	1	22.5234	2.0505
Rep/PR (Replication/PR)	4	7.4245	0.6759
PR	1	18.8151	1.7129
PI	1	24.5026	2.2307
PD	1	2.5026	0.2278
PE	1	4.3776	0.3985
RI	1	1.8984	0.1728
RD	1	0.1276	0.0116
RE	1	2.5026	0.2278
ID	1	11.6901	1.0642
IE	1	5.7526	0.5237
IRep/PR	4	12.9453	1.1785
DE	1	10.3359	0.9410
DRep/PR	4	12.8828	1.1728
ERep/PR	4	10.2891	0.9367
PRI	1	7.3151	0.6660
PRD	1	10.3359	0.9410
PRE	1	1.6276	0.1482
PID	1	1.6276	0.1482
PIE	1	17.9410	1.6332
PDE	1	3.5651	0.3246
RID	1	3.5651	0.3246
RIE	1	0.2109	0.0192
RDE	1	0.4401	0.0401
IDE	1	5.7526	0.5237
IDRep/PR	4	15.7785	1.4364
IERep/PR	4	14.6431	1.3331
DERep/PR	4	0.4141	0.0377
PRID	1	69.1901	6.2990*
PRIE	1	19.7109	1.7945
PRDE	1	3.1901	0.2904
PIDE	1	0.4401	0.0401
RIDE	1	27.6276	2.5152
IDERep/PR	4	23.9344	2.1789
PRIDE	1	27.6272	2.5151
S/PRIDERep	128	10.9844	

*$p < .05$

Summary Table for Analysis of Variance Performed

on Trials to Criterion (Continued)

Source	df	MS	F
L (List)	1	582.6274	78.2082*
LP	1	172.0027	23.0885*
LR	1	34.4402	4.6230*
LI	1	16.2524	2.1816
LD	1	0.2109	0.0283
LE	1	1.6277	0.2185
LRep/PR	4	13.7577	1.8467
LPR	1	2.5025	0.3359
LPI	1	0.5860	0.0787
LPD	1	0.5858	0.0786
LPE	1	1.6275	0.2185
LRI	1	20.6277	2.7689
LRD	1	2.1900	0.2940
LRE	1	1.1483	0.1541
LID	1	0.3150	0.0423
LIE	1	2.5025	0.3359
LIRep/PR	4	1.4037	0.1884
LDE	1	13.8775	1.8628
LDRep/PR	4	5.9453	0.7981
LERep/PR	4	1.9974	0.2681
LPRI	1	2.1898	0.2939
LPRD	1	11.0027	1.4769
LPRE	1	19.7109	2.6459
LPID	1	9.6903	1.3008
LPIE	1	27.6273	3.7085
LPDE	1	2.5027	0.3360
LRID	1	0.3150	0.0423
LRIE	1	0.7527	0.1010
LRDE	1	14.6485	1.9663
LIDE	1	7.3153	0.9820
LIDRep/PR	4	13.8409	1.8579
LIERep/PR	4	16.0179	2.1501
LDERep/PR	4	3.9766	0.5338
LPRID	1	5.7523	0.7722
LPRIE	1	4.8152	0.6464
LPRDE	1	2.8357	0.3806
LPIDE	1	9.6898	1.3007
LRIDE	1	0.0236	0.0032
LIDERep/PR	4	12.6226	1.6944
LPRIDE	1	16.2515	2.1815
LS/PRIDERep	128	7.4497	

$*p < .05$

Summary Table for Analysis of Variance

Performed on Percent of Transfer

Source	df	MS	F
R (Rule)	1	2172.6082	2.3442
I (Information)	1	24044.3828	25.9437*
D (Degree of Learning)	1	106.7410	0.1152
RI	1	89.3203	0.0964
RD	1	6456.0078	6.9660*
ID	1	10.0519	0.0108
RID	1	3140.8582	3.3890
S/RID (Subjects/RID)	88	926.7903	
L (List)	1	105758.4375	107.7057*
LR	1	4185.6250	4.2627*
LI	1	7974.0000	8.1208*
LD	1	2.2500	0.0023
LRI	1	673.3047	0.6857
LRD	1	4600.8672	4.6856*
LID	1	1709.2578	1.7407
LRID	1	489.2656	0.4983
LS/RID	88	981.9204	

*p < .05

Summary Table for Analysis of Variance

Performed on Errors on Trial 1

Source	df	MS	F
P (Paradigm)	1	343.1484	53.1152*
R (Rule)	1	46.0651	7.1303*
I (Information)	1	95.0026	14.7052*
D (Degree of Learning)	1	4.3776	0.6776
PR	1	0.5858	0.0907
PI	1	99.0233	15.3276*
PD	1	0.0233	0.0036
RI	1	1.6276	0.2519
RD	1	1.8984	0.2939
ID	1	7.3151	1.1323
PRI	1	0.9403	0.1455
PRD	1	53.2527	8.2429*
PID	1	6.2528	0.9679
RID	1	22.5234	3.4864
PRID	1	0.5858	0.0907
S/PRID (Subjects/PRID)	176	6.4605	
L (List)	1	534.3984	102.4695*
LP	1	288.7734	55.3715*
LR	1	17.0857	3.2761
LI	1	67.5024	12.9434*
LD	1	0.2107	0.0404
LPR	1	5.7527	1.1031
LPI	1	60.9609	11.6891*
LPD	1	0.0027	0.0005
LRI	1	1.3778	0.2642
LRD	1	1.1487	0.2203
LID	1	0.1278	0.0245
LPRI	1	0.1273	0.0244
LPRD	1	7.3147	1.4026
LPID	1	0.7523	0.1442
LRID	1	3.9607	0.7595
LPRID	1	13.1280	2.5173
LS/PRID	176	5.2152	

*$p < .05$

Summary Table for Analysis of Variance
Performed on Errors on Trials 2-6

Source	df	MS	F
P (Paradigm)	1	41.1255	2.7579
R (Rule)	1	6.1880	0.4150
I (Information)	1	5.5255	0.3705
D (Degree of Learning)	1	2.0672	0.1386
PR	1	9.4922	0.6365
PI	1	64.1672	4.3031*
PD	1	4.3130	0.2892
RI	1	3.0880	0.2071
RD	1	18.2130	1.2214
ID	1	14.5255	0.9741
PRI	1	0.7130	0.0478
PRD	1	17.4422	1.1697
PID	1	0.5005	0.0336
RID	1	7.3755	0.4946
PRID	1	25.9005	1.7369
S/PRID (Subjects/PRID)	176	14.9120	
T (Trials)	4	906.8469	507.6191*
TP	4	23.9627	13.4134*
TR	4	3.0382	1.7007
TI	4	3.6023	2.0164
TD	4	1.6179	0.9057
TPR	4	1.6706	0.9351
TPI	4	2.7701	1.5506
TPD	4	1.0565	0.5914
TRI	4	0.4488	0.2512
TRD	4	4.7665	2.6681*
TID	4	0.4305	0.2410
TPRI	4	2.4121	1.3502
TPRD	4	0.8966	0.5019
TPID	4	0.1189	0.0666
TRID	4	4.1632	2.3304
TPRID	4	1.6726	0.9363
TS/PRID	704	1.7865	
L (List)	1	1081.5005	103.3352*
LP	1	320.9502	30.6662*
LR	1	32.8127	3.1352
LI	1	36.0254	3.4422
LD	1	0.3794	0.0363
LPR	1	21.4631	2.0508
LPI	1	3.7629	0.3595
LPD	1	0.2295	0.0219
LRI	1	10.9505	1.0463
LRD	1	1.9381	0.1852
LID	1	0.5006	0.0478
LPRI	1	1.0545	0.1008

*p < .05

Summary Table for Analysis of Variance

Performed on Errors on Trials 2-6
(Continued)

Source	df	MS	F
LPRD	1	11.2544	1.0753
LPID	1	2.9295	0.2799
LRID	1	2.4795	0.2369
LPRID	1	0.7926	0.0757
LS/PRID	176	10.4659	
TL	4	19.2514	11.6473*
TLP	4	37.1386	22.4692*
TLR	4	1.4832	0.8974
TLI	4	2.9587	1.7901
TLD	4	1.2238	0.7404
TLPR	4	3.7166	2.2486
TLPI	4	4.3733	2.6459*
TLPD	4	0.5754	0.3481
TLRI	4	1.7877	1.0816
TLRD	4	0.9780	0.5917
TLID	4	6.0434	3.6563*
TLPRI	4	0.8822	0.5337
TLPRD	4	0.1909	0.1155
TLPID	4	0.8057	0.4875
TLRID	4	2.2860	1.3831
TLPRID	4	2.9938	1.8113
TLS/PRID	704	1.6529	

*$p < .05$