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TERRY M. LIBKUMAN

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INTRODUCTION

The present study was primarily concerned with the opposed predictions from attention theory (Zeaman & House, 1963) and frequency theory (Ekstrand, Wallace & Underwood, 1966) as applied to normal children and retardates in a verbal-discrimination (VD) task.

Zeaman & House proposed a two-stage theory to explain normal-retardate differences in discrimination learning. According to the theory, subjects (Ss) must learn a chain of two responses: (1) attending to the relevant stimulus dimensions and (2) making the appropriate instrumental response. The fundamental difference between normals and retardates is assumed to occur in the attention phase: the retardate has a more difficult time learning to attend to the appropriate stimulus dimensions.

On the other hand, Ekstrand, *et al*., in a recent theoretical analysis of normal adult VD learning, provided some suggestions that may explain, at least in part, normal-retardate differences in discrimination. The authors postulated that the subjective difference in frequency between the right (R) and wrong (W) words in each pair is the cue used to learn a VD list. The differential accrual of frequency units to the R and W words is assumed to occur as a result of a number of components operating in VD learning: representational responses (RRs) to both items during the anticipation interval resulting in one frequency unit being added to each item of the pair; pronunciation responses (PRs) to the selected item during the anticipation interval resulting in one frequency unit being added to the pronounced item (since there is a 50:50 chance of selecting either item on the first trial, there would be, at this stage, a R/W ratio of either 2:1 or 1:2); and rehearsal-of-the-correct responses (RCRs) during the feedback interval resulting in one frequency unit being added to the R item.

Ekstrand, et al., assumed that only one RCR was necessary for learning to occur, e.g., the addition of one RCR would result in either a 2:2 (giving the S an equal chance of picking the R item on the next trial) or 3:1 R/W ratio. Therefore, as trials continue, frequency units would occur at a differential rate in favor of the R item permitting the S to use the frequency cue to learn the list. Although not stated by Ekstrand, et al., one of the implications that may be generated from frequency theory is that the retardate may require a larger frequency difference than the normal in order to learn a discrimination.

One of the testable distinctions between attention and frequency theories concerns the effects of pretraining on subsequent discrimination learning. Attention theory predicts that pretraining will increase the probability of attending to the relevant stimulus cues. Consequently, if attention theory is applicable to VD learning, increasing the word frequency of both the R and W items should increase the attention value of the words and therefore increase the performance of retardates relative to normals.

On the other hand, frequency theory predicts that pretraining would result in a decrease in performance for both normals and retardates. This result would be expected, according to an analogy from Weber's law, in that adding frequency units to low frequency pairs would be more discriminable than adding units to high frequency pairs. Furthermore, if the retardate cannot effectively utilize the frequency cue as well as the normal, this inability should be reflected more so in the high frequency condition.

Evidence to support either theory has been equivocal. In non-verbal tasks, pretraining on both the correct and incorrect stimuli facilitated discrimination learning in the retarded (Dickerson, Girardeau & Spradlin, 1964; House, 1964; Milgram & Noce, 1968). However, in the normal VD literature, several studies (Berkowitz, 1968; Lovelace, 1968; Palermo & Ullrich, 1968; Postman, 1962; Underwood &

Freund, 1970) have favored the predicted inverse relationship between frequency and learning rate when low and high frequency lists were compared, but other studies have reported null effects (Keppel, 1966; Schultz & Hopkins, 1968, Exp. III, the visual condition) or a positive relationship (Runquist & Freeman, 1960; Schultz & Hopkins, 1968, Exp. III, the aural condition).

Pronunciation provides another approach in which attention and frequency theories may be evaluated in the VD task using the anticipation method of presentation. There are at least four possible ways in which pronunciation may be manipulated in the VD task: NVD (normal VD)--S pronounces his choice during the anticipation interval; RR--S pronounces both words and then his choice during the anticipation interval; RCR--S pronounces his choice during the anticipation interval and pronounces the R item during the feedback interval; and RR-RCR--S pronounces both words and then his choice during the anticipation interval and pronounces the R item during the feedback interval.

Attention theory would predict faster learning for the RR-RCR condition since pronunciation during the anticipation and feedback intervals would continuously focus the retardate's attention on the discriminative stimuli. In contrast, the RR and RCR conditions should result in decreased performance relative to the RR-RCR condition in that the retardate may not be attending to the R and W items during the anticipation interval in the RCR condition or not attending to the R item in the feedback interval in the RR condition. Furthermore, there may or may not be a performance difference between the RR and RCR conditions depending upon the relative importance of attention processes operating in the anticipation and feedback intervals. In other words, if attention to the R item in the feedback interval is more critical for VD learning, the RCR condition would be superior to the RR condition. However, the RR condition would produce superior performance relative to the RCR condition if attending to both items during the anticipation interval is a critical determinant of VD learning. Finally, the NVD condition should produce the largest decrease in the retardate's performance due to the combined effects of non-attention to the relevant stimuli during the anticipation and feedback intervals. In contrast, normal children should not be differentially affected by the pronunciation conditions due to the absence of an attention deficit in this population. In summary, attention theory predicts an interaction between pronunciation and intelligence, e.g., the NVD condition producing the greatest performance difference in favor of the normals followed by the RR and RCR conditions with normals equal to retardates under the RR-RCR condition.

On the other hand, frequency theory, under the assumption that RRs, PRs, and RCRs are qualitatively the same, would predict no effect due to pronunciation nor a pronunciation X intelligence interaction since the same frequency R/W ratio of at least 3:1 would occur in each condition.

The VD task may also reflect other processes that may differentiate normals and retardates. During the feedback interval Ss have the opportunity to covertly or overtly rehearse the R item. Adding frequency units via rehearsal would increase the frequency ratio and therefore increase VD learning. However, there is some evidence that retardates do not rehearse unless instructed to do so in a PA task (Gordon & Baumeister, unpublished) or a short-term memory (STM) task (Ellis, 1968). Consequently, in the VD task, a rehearsal deficit should reflect decreased performance for retardates under the NVD and RR conditions relative to the RCR and RR-RCR conditions.

Finally, the VD task may be conceptualized as a Type II (McLaughlin, 1965) learning situation in which intentional and incidental learning occur simultaneously. The intentional aspect requires S to recognize and pronounce the R items while the incidental components include learning the R and W items as responses and learning the associations between the R and W items (Kausler, 1966). Consequently, the VD task provides an appropriate test of the incidental learning deficit hypothesis in the retarded (Denny, 1964). Denny proposed that the retardate's poor performance, relative to normals, may be due to a deficit in incidental learning rather than in intentional learning. Previous research, employing non-verbal tasks (Baumeister, 1963; Goldstein & Kass, 1961; Hetherington & Banta, 1962) or a verbal PA task (Baumeister & Berry, 1968), has generally supported an incidental learning deficit in the retarded although this effect, in a few of the above studies, apparently disappears within a two day retention interval. In the present study, an associative matching task (AMT) was given immediately after VD learning in order to assess the validity of the incidental learning deficit hypothesis in a VD task as measured by learning of associations.

METHOD AND PROCEDURE

Subjects

A sample of 64 retardates (34 males, 30 females) were selected from the Special Education Classes at the Midwest City-Del City Public Schools and randomly assigned to eight treatment conditions ($n = 8$). The overall means for CA, MA, and IQ were 14.8 ($SD = 2.4$), 9.3 ($SD = 1.6$), and 66.3 ($SD = 10.2$), respectively. The treatment conditions did not differ with respect to MA, CA or IQ.

A sample of 64 normals (34 males, 30 females) matched for retardate MA were selected from the same school system and randomly assigned to the same eight treatment conditions ($n = 8$). The overall means for CA, MA, and IQ were 8.9 (*SD* = 1.6), 9.2 (*SD* = 1.7), and 101.2 (*SD* = 6.83), respectively. The treatment conditions did not differ with respect to MA, CA or IQ.

Finally, no sex differences were noted within the retarded group ($p > .05$) or the normal group ($p > .20$) and all *Ss* were naive with respect to past experience in verbal learning research.

Apparatus & materials

A pool of 36 monosyllable nouns (frequency between 1,000 and 2,000) were selected from the Thorndike & Lorge (1944) norms for juveniles and used to construct the various word lists. In all lists the inter-word associations were kept to a minimum and word length ranged from 3 to 5 letters. The words were exposed via a Lafayette memory drum unless otherwise noted.

Procedure

The experiment was conducted in the following temporal order:

Screening phase. Initially all *Ss* pronounced the pool of 36 words. The words were presented serially for one trial with an exposure rate of 4 sec. The screening trial was used to exclude *Ss* that could not adequately pronounce the words (none of the normals but ten of the retardates were excluded for this reason).

Pretraining phase. A total of 32 words were selected from the word pool and used to construct two sixteen word serial lists. The words were randomly assigned to either list 1 or list 2 with the restriction that an approximate equal number of three, four, and five letter words appeared in both lists. In addition, each list was arranged in four random serial orders. The lists were randomly assigned to either a low frequency or high frequency condition. In the low frequency condition, half of the normals and retardates pronounced words that were not employed in the VD learning phase. In the high frequency condition the remaining Ss pronounced words that were later employed in the VD learning phase. In both conditions Ss pronounced the words for ten trials with an exposure duration of 2 sec. and intertrial interval of 4 sec.

Demonstration phase. A two pair word list was constructed from the four remaining words in the word pool and printed on 3 x 5 cards with the word pairs in horizontal alignment. Each S practiced on the list, under one of the four different pronunciation conditions (described below), via E presentation until S was judged to understand the nature of the task.

VD learning phase. The VD list was composed of eight pairs of words that were previously employed in the high frequency condition in the pretraining phase. The list was arranged in four random serial orders with the left-right spatial position of each pair randomized within each serial order. In addition, successive spatial position for any word was limited to three. Each word pair was juxtaposed and presented via the anticipation method at a 4:4 sec. rate with an 8 sec. intertrial interval. The R items were underlined during the feedback interval. Normals and retardates were instructed to learn the VD list under one of the following conditions: NVD; RR; RCR; and RR-RCR. Learning was carried to one perfect trial or 15 trials, whichever came first. Furthermore, Ss were not informed about the relationship between pretraining and VD learning. Overall, the design was a 2 X 2 X 4 factorial with two levels of intelligence, two levels of frequency, and four levels of pronunciation.

Associative learning phase. Immediately following VD learning all Ss received an AMT. The R and W words were presented on paper in different columns and S was instructed to draw a line between the words that were originally paired in the VD task. The words in each column were randomized with respect to serial position. Finally, no time limits were set for the AMT.

RESULTS

A 2 X 2 X 4 analysis of variance (Intelligence X Frequency X Pronunciation) was employed to evaluate each dependent measure. The dependent measures were number of trials to criterion, number of errors to criterion, number of errors over the first five trials, and associative matching scores (the number of pairs that were correctly matched).

The trials analysis revealed two significant effects: pronunciation ($\underline{F}$ = 3.93, $\underline{df}$ = 3/112, $\underline{p} < .025$) and intelligence ($\underline{F}$ = 3.94, $\underline{df}$ = 1/112, $\underline{p} < .05$). The latter condition indicated that normals ($\underline{M}$ = 7.10, $\underline{SD}$ = 3.39) required fewer trials than the retardates ($\underline{M}$ = 8.45, $\underline{SD}$ = 4.23) to learn the VD task. The Newman-Keuls test for individual comparisons of pronunciation conditions indicated (all comparisons were tested at the five percent level) that the RR condition ($\underline{M}$ = 9.56, $\underline{SD}$ = 3.82) required more trials than the remaining conditions. The NVD condition ($\underline{M}$ = 6.34, $\underline{SD}$ = 4.13) required the least number of trials relative to the other three conditions with no difference between the RCR ($\underline{M}$ = 7.84, $\underline{SD}$ = 3.80) and RR-RCR ($\underline{M}$ = 7.37, $\underline{SD}$ = 3.55) conditions. Although not significant, a trend was noted for frequency ($\underline{F}$ = 3.58, $\underline{df}$ = 1/112, $\underline{p} < .10$) indicating a slight superiority for the low frequency condition ($\underline{M}$ = 7.14, $\underline{SD}$ = 3.63) relative to the high frequency condition ($\underline{M}$ = 8.42, $\underline{SD}$ = 4.02). The predicted Intelligence X Pronunciation ($\underline{F}$ = 1.18, $\underline{df}$ = 3/112, $\underline{p} > .25$) and Intelligence X Frequency ($\underline{F}$ = 0.01, $\underline{df}$ = 1/112, $\underline{p} > .25$) interactions did not approach significance as well as the remaining interactions.

In the errors to criterion analysis, the $\underline{F}$-max revealed heterogeneity of variance ($\underline{F}$ = 35.14, $\underline{df}$ = 8/16,

$p < .01$). Consequently, only the critical values that reached $p < .025$ are reported as significant. The errors analysis revealed only one significant effect: frequency ($F = 5.60$, $df = 1/112$, $p < .025$) which indicated that the low frequency condition ($M = 17.62$, $SD = 12.85$) produced the more efficient learners relative to the high frequency condition ($M = 24.01$, $SD = 17.36$). Trends were noted for the pronunciation conditions ($F = 2.29$, $df = 3/112$, $p < .10$) indicating the same order of difficulty as the trials analysis revealed and intelligence ($F = 3.07$, $df = 1/112$, $p < .10$) which indicated a slight superiority for normals ($M = 18.45$, $SD = 13.81$) relative to retardates ($M = 23.18$, $SD = 16.60$). The predicted Intelligence X Pronunciation ($F = 2.02$, $df = 3/112$, $p > .10$) and Intelligence X Frequency ($F = 0.65$, $df = 1/112$, $p > .25$) interactions as well as the remaining main effects and interactions did not approach significance.

The performance differences between the frequency conditions should be larger during the initial trials since, according to frequency theory, the R/W ratio would have to be larger in the high frequency condition relative to the low frequency condition in order for VD learning to begin. However, after the R/W ratio is large enough for VD learning to begin in the high frequency condition, the differences between low and high frequency condition should disappear since the R/W ratios in both conditions are large enough to permit Ss to use the frequency cue. Therefore, an analysis of total errors over the first five trials was conducted which revealed significant effects for pronunciation (F = 4.46, df = 3/112, $p < .025$) and frequency (F = 4.32, df = 1/112, $p < .05$). The latter manipulation indicated the superiority of the low frequency condition (M = 12.50, SD = 5.37) relative to the high frequency condition (M = 14.45, SD = 5.25). The means and standard deviations for the pronunciation conditions were: RR = 15.62, 4.98; RR-RCR = 13.99, 6.27; RCR = 13.36, 4.44; and NVD = 10.84, 5.39. Individual comparisons using the Newman-Keuls at the five percent level revealed the same significant relationships that were previously reported in trials analysis with the exception that the difference between the RR and RR-RCR conditions only approached significance ($p < .10$). The predicted Intelligence X Pronunciation (F = 1.32, df = 3/112, $p > .25$) and Intelligence X Frequency (F = 1.17, df = 1/112, $p > .25$) interactions again failed to reach significance. In addition, the remaining main effect and interactions were not significant.

A 2 X 2 X 5 mixed-effects analysis of variance (Intelligence X Frequency X Trials) was used to evaluate the effects of frequency and intelligence over the first five trials. Using errors as the dependent measure, the analysis revealed, as expected, a significant effect for trials (F = 93.64, df = 4/496, $p < .001$). Furthermore, significant interactions were found for Intelligence X Trials ($\underline{F}$ = 2.42, $\underline{df}$ = 4/496, $\underline{p} < .05$) and Frequency X Trials ($\underline{F}$ 2.84, $\underline{df}$ = 4/496, $\underline{p} < .025$). The former interaction indicated that normals made fewer errors than retardates on only the fifth trial ($\underline{t}$ = 1.53, $\underline{df}$ = 126, $\underline{p} < .025$) although the fourth trial, showing the same relationship, approached significance ($\underline{t}$ = 1.53, $\underline{df}$ = 126, $\underline{p} < .10$). In the latter interaction, the high frequency condition produced more errors than the low frequency condition for the third ($\underline{t}$ = 2.67, $\underline{df}$ = 126, $\underline{p} < .005$), fourth ($\underline{t}$ = 2.17, $\underline{df}$ = 126, $\underline{p} < .025$), and fifth ($\underline{t}$ = 1.75, $\underline{df}$ = 126, $\underline{p} < .05$) trials. The remaining main effects and interactions did not approach significance with the exception of the main effect for frequency ($\underline{F}$ = 3.49, $\underline{df}$ = 1/124, $\underline{p} < .10$).

Finally, the analysis on the associative matching scores revealed that none of the main effects or interactions approached significance. The overall mean and standard deviation was 2.80 and 1.93, respectively, indicating an approximate 35% efficiency in incidental learning.

DISCUSSION

The results of the present analysis provides little support for the operation of an attention deficit in the retarded. Contrary to attention theory (Zeaman & House, 1963), none of the predicted interactions, Frequency X

Intelligence and Pronunciation X Intelligence, approached significance. Relative to normals, retardates did not improve under a high frequency condition nor were normals and retardates differentially affected by pronunciation. In addition, given the assumption that both normal children and retardates were having problems in attending to the relevant stimuli, attention theory still cannot explain the adverse effects of pretraining as well as the superiority of the NVD condition. Perhaps, Zeaman & House (1963) would classify the discriminative stimuli in the VD task as too "easy" to reflect differences between normals and retardates, e.g., both populations may have a high probability for observing words relative to a position preference. However, even under these circumstances, some additional processes must be operating to account for the significant difference in favor of the normals in the trials analysis as well as the noted trend in the total errors analysis.

On the other hand, the absence of the Frequency X Intelligence interaction also failed to support the hypothesis that retardates do not utilize the frequency cue as effectively as the normals: the high frequency condition had an equally adverse effect on both normals and retardates which was especially reflected during the third, fourth, and fifth trials. The failure of the predicted interaction may have simply been a result of an insufficient number of training trials. In other words, the number of frequency units added to the R and W items during pretraining may not have been large enough to reflect performance differences between normals and retardates. Another explanation for the failure of the predicted interaction may be due to the words employed in the present study. It is plausible to assume that frequency of exposure for these words was much higher in the normals than in the retardates which, according to frequency theory, would make the discrimination easier for the latter population. In effect, the posited frequency cue deficit in the retarded may have been offset by the initial increased discriminability in this population.

Although the interaction was not significant, some support for a frequency cue deficit in the retarded was reflected in the error scores over the first five trials in which the means in the low frequency condition for normals ($\underline{M}$ = 12.62) and retardates ($\underline{M}$ = 12.37) were approximately equal while under the high frequency condition the normals made fewer errors ($\underline{M}$ = 13.56) than the retardates ($\underline{M}$ = 15.34). Furthermore, a frequency cue deficit seems to be a plausible alternative to attention theory in accounting for the superiority of the normals in the trials analysis and the trend in the errors analysis as well as the superior performance of normals on the fifth trial. The latter result may reflect that by trial four or five the differential cue is well established for normals but not for retardates.

In terms of the effects of pronunciation upon VD learning, no interaction, as predicted by frequency theory, occurred between pronunciation and intelligence. However, contrary to frequency theory predictions, the additional pronunciation required of Ss, relative to the NVD condition, had an adverse effect upon their VD learning. The explanation that pronunciation takes time away from learning, however, is not plausible since the RR condition required more trials and produced more errors over the first five trials than the RR-RCR condition (the difference between the two conditions was significant in the trials analysis but only approached significance in the errors analysis). Another possible explanation is that pronunciation during the feedback interval effectively interfered with rehearsal. Although no significant difference occurred between the RR-RCR and RR conditions and both were inferior to the NVD condition, interference with rehearsal cannot completely account for the results since the RR condition was most detrimental to VD learning.

A possible interpretation, based upon the differential accrual of frequency units to the R and W items, that seems compatible with the present results is to assume that instructions to pronounce the R item aloud during the feedback interval stops any additional covert rehearsal while in the absence of these instructions Ss spontaneously rehearse repeatedly. Furthermore, the assumption is made that in the RR condition, a set deriving from the instructions develops to counteract effective covert rehearsal. Overall, in the NVD condition, Ss may covertly rehearse the R item at least twice, resulting in a frequency differential of at least 4:1 in favor of the R item. In contrast, if no covert rehearsal occurs in the RCR and RR-RCR conditions the resultant frequency ratios would be assumed to be 3:1 and 4:2, respectively, with the added frequency units in the latter condition being attributable to pronunciation of both items during the anticipation interval. Furthermore, the tendency to develop a set to view both items and thus add additional frequency units to the W items is counteracted by forced pronunciation of the R items in the RR-RCR condition. The set to view both items during feedback may develop in the RR condition, due to the absence of forced rehearsal and the pronunciation of both items in the anticipation interval, resulting in a frequency ratio of 4:3. In summary, the present interpretation, though admittedly post-hoc, conforms to frequency theory predictions in that increases in the frequency differential between the R and W items increases VD performance if the following assumptions are accepted: that Ss covertly rehearse unless instructed to pronounce; that a set to view both items develops in the feedback interval when Ss are required to pronounce both items in the anticipation interval; and that this set is counteracted by forced pronunciation of the R item in the feedback interval.

Furthermore, this set appears to be temporary in that the differences between the pronunciation conditions disappeared as reflected in the total errors analysis. Also, the present results, contrary to previous research (Ellis, 1968; Gordon & Baumeister, unpublished), provide no support for a rehearsal deficit in the retarded, e.g., both populations performed equally well under all of the pronunciation conditions.

Finally, the AMT results provide no support for an incidental learning deficit in the retarded (Baumeister, 1963; Baumeister & Berry, 1968; Goldstein & Kass, 1961; Hetherington & Banta, 1962). However, the absence of a main effect for intelligence may have been due to differential learning rates in the intentional task, e.g., retardates in requiring more trials to learn in the intentional task had a greater opportunity for incidental learning. However, Pearson's $\underline{r}$ between the number of trials to criterion and associative matching scores revealed only one significant relation in the retarded ($\underline{r}$ = -63, $\underline{p} < .005$ for the high frequency RCR condition) while three were significant in the low frequency conditions for the normals (RR, $\underline{r} = -.68$, $\underline{p} < .005$; RR-RCR, $\underline{r} = +.61$, $\underline{p} < .01$; and NVD, $\underline{r} = +.78$, $\underline{p} < .005$). In other words, differential learning rates in the intentional task had little consistent and/or meaningful effect upon incidental learning.

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APPENDIX A

PROSPECTUS

PROSPECTUS

CHAPTER I

INTRODUCTION

The present study is concerned with the processes involved in verbal-discrimination (VD) learning as it applies to normal children and retardates and will include the following: (1) review of the pertinent literature in normal adult VD learning; (2) review of the pertinent literature in normal child VD learning; (3) review of the pertinent literature in retardate learning; and (4) proposal.

Normal adult literature

In the usual VD task, subject (S) is presented with a series of verbal unit pairs in which one member of each pair has been arbitrarily selected as correct by the experimenter (E). On each trial, including the first, which is essentially a guessing or study trial, the S's task is to select and pronounce the correct term of each pair. The E then informs S as to the correctness of his verbal choice via saying "right" or "wrong" or having the memory drum programmed to indicate the correct item. Generally, learning continues until some criterion is achieved, e.g., two successive perfect trials.

Ekstrand, Wallace & Underwood (1966) proposed a theory to account for acquisition and transfer in the VD task. These authors postulated that the subjective difference in frequency between the right (R) and wrong (W) items in each pair is the cue used to learn the list. The differential accrual of frequency units to the R and W items is assumed to occur as a result of a number of components operating in VD learning.

Initially, S perceives the R and W items as each pair is presented. This constitutes a representational response (RR; Bousfield, Whitmarsh & Danick, 1958) and results in one frequency unit being added to each item of the pair. The S then chooses and makes a pronunciation response (PR) to one of the items. The PR is assumed to add one frequency unit to the pronounced item. There would be, at this stage, a R/W ratio of either 2:1 or 1:2. Since there is a 50:50 chance of making a PR to either item the differential frequency cue would be useless and no learning would occur.

Consequently, Ekstrand, et al., suggested a third type of response, rehearsal-of-the-correct-alternative response (RCR), in which S, covertly or overtly, pronounces the R item following information from E as to which item was correct. The theory postulates that one frequency unit is added to the R item for every RCR, and only one RCR, although more than one may occur, is necessary for learning to occur. In the case of the 1:2 R/W ratio, the RCR would return the pair to a 2:2 ratio giving the S an equal chance of picking the R item on the next trial. On the other hand, with the 2:1 R/W ratio, adding the RCR would result in a 3:1 ratio further enhancing the frequency differential. Therefore, as trials continue, frequency units would accrue at a differential rate in favor of the R items permitting S to use Rule I: select the most frequent item of each pair.

A number of studies have tested the basic assumptions and/or implications from frequency theory as it applies to acquisition in VD. Perhaps the most fundamental assumption of frequency theory is that Ss can and do discriminate between verbal units on the basis of their frequency. That Ss can make accurate judgments based on frequency has been demonstrated for printed discourse (Underwood, 1966) and experimentally induced frequency (Hintzman, 1969; Underwood & Freund, 1970). Furthermore, if the frequency differential is the cue used to learn a VD list, then pairs in which S guesses the R item on the first trial should facilitate performance on later trials while W item guesses should result in no improvement. Dominowski (1966) presented evidence indicating that trial 1 guessing only slightly effected trial 2 performance whereas trial 1 guessing on trial 3 provided support for frequency theory. In all cases when the R item was guessed on trial 1, trial 3 performance was facilitated with no improvement occurring when the W item was guessed on trial 1.

A number of studies have tested the implication from frequency theory that directly manipulating the frequency of the R and/or W items should have an effect on VD learning efficiency. When the frequency of the R item was increased relative to the W item, VD learning increased (Ekstrand, et al., 1966; Runquist & Freeman, 1960; Underwood & Freund, 1968, 1969, 1970; Yelen, 1969). On the other hand, when the frequency differential between the R and W items was reduced, VD learning decreased (Ekstrand, et al., 1966; Goulet & Hoyer, 1969; Kausler & Sardello, 1967, Kausler & Boka, 1968; Sardello & Kausler, 1967; Underwood & Freund, 1968, 1969, 1970). Finally, if greater accrual of frequency units to the R items is the normal process in VD learning, then this effect should be reflected in a recognition test. Erlebacker, Hill & Wallace (1967) reported that R item recognition was higher than W item recognition following VD learning.

Ekstrand, et al., (1966) proposed that increasing formal intralist similarity (the similarity between the R and W items) would decrease performance in a VD task. According to this view, increasing intrapair or interpair similarity would result in the RRs, PRs, and RCRs of the R items being confused with the RRs, PRs, or RCRs of the W items. Underwood & Archer (1955), Battig & Brackett (1963), and Yelen (1969) all reported that increasing formal similarity resulted in decreased VD performance.

Another way in which similarity has been manipulated was through interpair and intrapair associations or secondary similarity. The theory assumes that frequency units can be added via implicit associative responses (IARs; Bousfield, et al., 1958). In other words, presentation of one verbal unit may elicit a response to an associatively related verbal unit, e.g., if table is presented, an IAR occurs to chair and one frequency unit is added to both items. In this manner, VD learning should be facilitated or inhibited depending upon the intrapair or interpair associative relationships. If the R items are associatively related (AR condition) in an interpair list, the frequency difference would be increased in favor of the R items and proficiency of learning should increase. If the W items are associatively related (AW condition) in an interpair list, the frequency difference would be reduced and learning should decrease. On the other hand, if the R items are associatively related to the W items (AB condition), the frequency difference would be reduced and an equal amount of interference should be produced for an interpair or intrapair list.

The support for increases or decreases in frequency units via IARs has been equivocal. In the interpair conditions, Ekstrand, et al., (1966) reported that the AR and

AB conditions were superior and inferior, respectively, to a control while the AW condition did not differ from the latter. On the other hand, Kanak, Cole & Thornton (1970) reported that AR was the most difficult and AW the easiest with an AR-AR condition equal to the control. The latter condition employed interpair associations in both the R and R items. According to frequency theory the AW-AR condition should equal the control since the differential frequency unit accrual for the R and W items is identical. In terms of the intrapair situation, Palermo & Ullrich (1968), Underwood & Vitrena (1951) and Youniss, Feil & Furth (1965) all reported that meaningful similarity produced interference while Putnam, Iscoe & Young (1962) reported that meaningful similarity produced facilitation.

Several studies have compared intrapair and interpair (the case in which associations of the R and W items were in different pairs) lists. According to frequency theory an equal amount of interference would be produced in both lists. Eberlein & Raskin (1968), Fulkerson & Kausler (1969), and Kausler & Olson (1969) all reported that the interpair condition produced interference but in opposition to the theory the intrapair list was learned as well as a control.

Barch, Lippmann & Whalen (1967) suggested an alternative process as a possible explanation for the lack of interference in the intrapair condition. According to this model S reduces his memory load by tagging one member of each pair as correct and then collapses the tag and pair together into memory storage for later retrieval. The ease with which the tagging and collapsing occurs is dependent upon the associative strength between the members of the pair. As the associative strength increases, tagging and collapsing would increase allowing this process to take over as the frequency cue becomes less perceptable. In support of the model, two studies (Fulkerson & Kausler, 1969; Kausler & Olson, 1969) have reported that clustering as measured by free recall was higher for intrapairs than interpairs.

Ekstrand, et al., (1966) implied that learning a VD list composed of high frequency items would be more difficult than a list of low frequency items. This result would be expected, according to an analogy from Weber's law, in that adding a frequency unit to low frequency pairs would be more noticeable or discriminable than adding one to high frequency pairs.

A number of studies have tested Weber's analogy with equivocal findings. When pre-experimental frequency was contrasted by means of homogenous lists composed of either low R item frequency-low W item frequency (LL) pairs or high R item frequency-high W item frequency (HH) pairs, results in favor of Weber's analogy were reported by Postman (1962), Lovelace (1968) and Berkowitz (1968). On the other hand, dissonant results have been reported by Runquist & Freeman (1960), Keppel (1966) and Schultz & Hopkins (1968).

A more stringent test of Weber's analogy was reported by Underwood & Freund (1970). The authors varied frequency input in the experimental situation before VD learning. In general, errors decreased in VD learning as the frequency difference between the R and W items increased for pairs of low induced frequency. However, when the pairs were of high frequency, discrimination was very poor: as the frequency difference increased VD learning did not increase.

According to frequency theory, increasing the anticipation interval should result in an equal number of additional frequency units being added to the R and W items via RRs. Consequently, in accord with Weber's analogy, the only effect, if any, on performance would be inhibitory. On the other hand, increasing the feedback interval should result in more RCRs and increased VD learning efficiency. Although not directly relevant to frequency theory predictions, Kanak (1968) reported that an exposure rate of 1:1 produced more errors and trials to criterion than the 2:2 or 4:4 rate. In addition, and in conflict with Bugelski's (1962) total time hypothesis, total time to learn increased with longer exposure durations: the 4:4 rate requiring more time per pair than the 1:1 or 2:2 rate. Kanak pointed out that the increase in total time for the 4:4 rate may have been a result of increased attention to the W items via RRs and RCRs thereby offsetting the dominance of the R items as predicted by frequency theory.

The application of Rule 1 is assumed to be the basis for learning a single VD list. In transfer, however, Rule 1 or Rule 2, selecting the least frequent item, may be used depending upon the relationships between list 1 and 2. If the same list 1 R items remain in list 2 but the W items are replaced with new W items, the frequency difference in favor of the R items would be increased and Rule 1 would be utilized resulting in high positive transfer. In addition, the same effect should occur when list 1 W items become list 2 R items and paired with new W items. In support of frequency theory, high positive transfer has been found for both paradigms (McClelland, 1942; Underwood, Jesse & Ekstrand, 1964; Raskin, Boice, Rubel & Clark, 1968). Furthermore, the same results have been reported when list 1 R items were replaced with strong associates (Raskin, et al., 1968) or homonymns (Kausler & Olson, 1969) in list 2 and paired with new W items. However, these effects were only observed when S was informed of the interlist relationships.

On the other hand, if list 1 R items are replaced by new R items in list 2 and paired with the same W items Rule 2 would be initially appropriate. However, as transfer trials increase, building up frequency units at a faster rate in favor of the new R items, a point should be reached where neither Rule 1 or 2 would be appropriate (the R and W items should have an equal number of frequency units) and discrimination should be disrupted. If trials continue beyond this point, Rule 1 would again be required to master the list. In addition, the same effect should be observed for any transfer list in which the W items have more frequency units than the R items (R and W items reversed, list 2 W items replaced with strong associates to list 1 R items and paired with new R items or new list 2 R items paired with the old list 1 R items). Overall, in terms of performance, facilitation would be negligible on intermediate trials with positive transfer occurring for earlier and later trials. Only one study (Raskin, et al., 1968) has found the same relationship and in this case positive transfer still occurred to some degree on the intermediate trials. Other studies have reported negative transfer in the absence of instructions concerning the interlist relationships (McClelland, 1942), initial high positive transfer followed by slow improvement when instructions were given (Underwood, et al., 1964; Underwood & Freund, 1970) or that the effect depended upon the presence of instructions when strong associates were employed (Raskin, et al., 1968).

Finally, Kausler & Farzanegan (1969) investigated general selection strategies as a higher order process in VD learning via list 1-list 2 relationships in which specific item content between the two lists were unrelated. There were three list 1 conditions composed of either low frequency-high frequency R-W pairs (LH), high frequency-low frequency R-W pairs (HL) or a mixed list of LH-HL pairs. In the second list Ss received either LH, HL, or LH-HL pairs for each list 1 condition. The authors hypothesized that transfer for the HL, HL and LH, LH conditions should be high due to a generalized strategy to use Rule 1 for the former condition and Rule 2 for the latter condition. Positive transfer should also occur for the HL, LH and LH, HL conditions since S cannot efficiently transfer Rule 1 or 2 used in list 1 to list 2. In general, results in support of general selection strategies were found. Facilitation occurred for HL, HL and HL, LH while interference occurred in the LH-HL, HL Condition. In addition, LH-HL, LH and LH-HL, LH were inferior to the LH-HL, LH-HL condition. However, no selection strategies were evident in the three remaining conditions: no facilitation occurred for the LH, LH and HL, LH conditions and no interference occurred in the LH-HL, LH condition.

A number of studies have investigated incidental learning in VD. The VD task may be conceptualized as a Type 11 learning situation in which intentional and incidental learning occur simultaneously (McLaughlin, 1965). The intentional aspect requires S to recognize and pronounce the R items while the incidental components includes learning the R and W items as responses and learning the associations between the R and W items (Kausler, 1966).

In support of Type 11 incidental learning in VD, Kausler & Sardello (1967) and Sardello & Kausler (1967) reported that as practice trials increased response and associative learning increased. Furthermore, in the former study, when S was required to pronounce both items during informative feedback, free recall of the R and W items was equal while in the no pronunciation condition R item recall was superior to W item recall. However, in the latter study, using modified free recall (MFR) as the dependent measure, associative symmetry (R-W equaled W-R recall) occurred for both the pronunciation and no pronunciation conditions. In direct opposition to these results, Goulet & Hoyer (1969) reported that W-R was superior to R-W regardless of pronunciation.

Kanak (1968) reported that rate of exposure effected the amount of incidental learning. The MFR measure revealed that R-W was superior to W-R with increasing exposure rates producing increases in overall associative learning. However, the relationship was not linear with symmetry occurring for the 2:2 and 4:4 rates and asymmetry occurring in the 1:1 rate.

Zechmeister & Underwood (1969) provided further evidence to indicate that associative and response learning can be viewed as incidental components in VD. After a number of VD trials, ranging from 5 to 35, Ss were either given an associative matching task (AMT), free recall or 10 trials on a paired associate (PA) task. In the PA task, half the Ss received the R and W items as stimuli and responses, respectively, while the other half were given the opposite.

In the PA task, the results indicated that W-R performance increased as VD trials increased while R-W only increased for the first 10 trials. Overall, W-R was superior to R-W. The results of the AMT indicated that the degree of association increased with continued practice. Finally, free recall data indicated that only 50% of the items were recalled with R item recall higher than W item recall but performance did not improve with increased VD practice.

Finally, Kausler & Boka (1968) contrasted the effects of double function (DF), partial double function (PDF) and single function (SF; normal VD list) lists in VD learning. In a DF list the same verbal units serve as the R item in one pair and the W item in another pair. In the PDF list half the pairs were DF and the other half SF. According to frequency theory, a DF list should be almost impossible to learn since an equal number of frequency units accrues to both items within any pair. If learning does occur some other process must be responsible, e.g., associative learning. In effect, recognition learning in a DF list must be dependent upon incidental associative learning.

The intentional data indicated that all Ss in the PDF and DF conditions failed to reach criterion whereas the SF condition was learned within 15 trials. In the incidental task, MFR scores revealed superior recall for the SF condition with no differences between the PDF and DF conditions. Kausler & Boka attribute the inferior recall of the latter two groups to competition between forward (W-R) and backward (R-W) associations. In effect the same item serves as a stimulus for both forward and backward associations.

In terms of the relations between intentional and incidental learning the data indicated that associative learning did not covary with VD learning in the SF list. On the other hand, incidental learning increased as VD learning increased in the PDF and DF groups with a higher correlation for the latter. In other words, Ss were forced to discriminate between verbal units on the basis of associative processes when the frequency differential was inadequate. In addition, when Ss in the PDF (only for the pairs which were DF) and DF conditions were separated into subgroups on the basis of associative learning and DF performance, the high associative learners, relative to low associative learners, acquired more intraitem associations and learned more DF pairs.

Normal child literature

Only a few studies have been concerned with the implications of frequency theory in VD as it applies to children. These studies will be reviewed as well as studies that may provide some insight into the developmental processes operating in VD learning.

Bauer (1967) compared 4th, 6th, and 8th grade children on intentional and incidental learning using a 12 pair list. No differences were found between grades for intentional and incidental associative learning. However, when Ss were divided into fast and slow learners for each grade level, positive correlations were obtained between intentional and incidental learning for the 8th graders, while negative correlations occurred for the 4th and 6th graders. In other words, poor and good intentional learners were poor and good incidental learners, respectively, for the 8th graders while poor and good intentional learners were good and poor incidental learners, respectively, for the 4th and 6th graders. Finally, W-R recall was superior to R-W recall for the 6th and 8th grades with associative symmetry occurring for the 4th grade.

Goulet & Hoyer (1969) compared 5th grade children and adults, with and without pronunciation of the R and W items during the feedback interval, on intentional and incidental VD learning. Adults were found to be more efficient learners than 5th graders with faster learning occurring for both groups under the no pronunciation condition. Furthermore, pronunciation increased associative learning in both groups with W-R recall superior to R-W recall for adults. However, this effect was only found under the no pronunciation condition for the 5th graders while in the pronunciation condition R-W was superior to W-R.

Goulet (1969), employing 4 pairs of animal line drawings, investigated the effects of pronunciation of the R and W items, prior to S's choice, on VD learning and transfer (list 1 R items remained in list and paired with new W items). The acquisition data indicated that pronunciation increased learning efficiency relative to a no pronunciation condition. In transfer, however, this difference disappeared with high positive transfer occurring for both groups.

A few studies have investigated the effects of intrapair meaningful similarity on VD learning with equivocal findings. Barch, Lippmann & Whalen (1967) compared the VD learning of 4th, 6th, and 8th grade children on a 16 pair mixed list composed of 8 different classes of intrapair relationships. In addition, Ss were tested in groups with a study-test procedure and oral presentation. The results indicated that errors increased as grade level decreased but within any one grade level, learning was facilitated for intrapairs in which associative similarity was present.

In direct opposition to these findings, Palermo & Ullrich (1968), using a 21 pair mixed list composed of low, medium and high associative similarity, reported that as associative similarity increased, VD learning decreased for 4th grade children. In addition, Ahammer & Goulet (1969) reported the same relationship for grades 1 through 6 in an unmixed list procedure using familiar pictures as stimuli.

Finally, one study (Barch, _et_ _al_., 1967) reported that high frequency pairs were more difficult to learn than low frequency pairs for 4th, 6th, and 8th grade children.

Retardate learning

Zeaman & House (1963) proposed a two-stage model to explain normal and retardate discrimination learning. According to this model, Ss must learn a chain of two responses: (1) attending to the relevant stimulus dimensions (defined as broad classes of cues that have a common stimulus property, e.g., color would be a dimension while the cues would be the specific colors) and (2) making the appropriate instrumental response. Furthermore, the latter process is assumed to depend upon the former. In other words, S must make the appropriate observational responses before he can make the correct instrumental response.

The fundamental difference between normals and retardates is assumed to occur in the attention phase rather than in the instrumental phase. According to this view, the retardate distributes his attention more evenly over fewer irrelevant and relevant stimulus dimensions than the normal. In other words, normals observe more dimensions but then are able to ignore the irrelevant and attend to the relevant ones. On the other hand, the retardate not only observes fewer dimensions but is unable to effectively ignore the irrelevant and "zero" in on the relevant ones.

There has been a number of studies (see Denny, 1964; Shepp & Turrisi, 1966; Zeaman & House, 1963) that have tested the predictions of attention theory as it applies to retardation. However, as Ross (1966) points out, most of the evidence has been derived from transfer experiments in which performance is compared on various reversal and non-reversal procedures using objects as discriminative stimuli. These studies will not be reviewed. However, the few studies that have compared normals and retardates on acquisition in discrimination tasks will be reviewed as well as studies that may have implications regarding the applicability of frequency theory to retardate discrimination learning.

The two most recent reviews on discrimination learning in normals and retardates of comparable MAs differed with respect to their conclusions. Stevenson (1963) reported that in three studies normals learned a discrimination task faster than retardates while in five other studies no differences in learning rate were found. Stevenson pointed out that, due to the diversity in methodological variables among the studies, no conclusions could be made with regard to rate of discrimination learning in normals and retardates.

On the other hand, Denny (1964) concluded by stating that mentally retarded individuals suffer a LOW-IQ deficit. The latter concept refers to learning differences in favor of normals when they are compared to retardates of the same MA. Since MA is held constant the deficit can only be attributable to a low IQ. The LOW-IQ deficit was found to be especially apparent in retardates with IQs below 50.

A number of studies have investigated the effects of various types of pretraining on discrimination learning in the retarded. Frequency theory, of course, would predict that any method which increases the frequency of the correct objects would facilitate learning while increasing the frequency of both objects or the incorrect objects would retard learning.

House (1964) compared the effects of a demonstration trial relative to the usual trial-and-error procedure. The demonstration occurred on the first trial and consisted of the E showing S the correct or incorrect object and verbalizing the relationship between the objects and reward. The results indicated that the demonstration trial facilitated performance but it was still less effective than the trial-and-error procedure.

Fletcher, David, Orr, & Ross (1965) investigated the effects of prompting on normal and retardate discrimination learning. The prompting method, which consisted of presenting a light cue indicating the correct object, was compared to a trial-and-error procedure. Subjects under both conditions were run for 36 trials on 2 object discrimination problems. In the prompting condition, Ss received the light cue for the first 6 trials with the remaining trials executed without a prompt. In the trial-and-error condition, Ss performed without the aid of a prompt for the entire 36 trials. The results indicated, for both normals and retardates, that prompting facilitated discrimination learning relative to the trial-and-error condition.

Several other studies have provided support for prompting. Fletcher (1965; 1966) reported that prompting plus trial-and-error was superior to trial-and-error alone and that as prompting trials increased discrimination learning increased. Finally, Sanders, Zigler & Butterfield (1968) reported that positive cues (indicating the correct stimulus) facilitated learning relative to a control which, in turn, was superior to negative cues (indicating the incorrect stimulus). In terms of normal-retardate comparisons no differences were reported for the positive and control conditions with definite superiority of the normals in the negative condition.

A few studies have investigated the effects of naming stimuli during pretraining on subsequent discrimination learning. Cantor & Hottel (1957) and Smith & Means (1961) both reported that learning distinctive names for stimuli facilitated the performance of the retardates. Furthermore, Dickerson, Girardeau & Spradlin (1964) reported that naming either the positive, negative or both stimuli (relevant conditions indicating the correct, incorrect, or both respectively) facilitated performance relative to irrelevant naming (naming stimuli that were not used in the discrimination task). However, no differences were found between the relevant conditions with the exception that Ss in the negative condition did not improve over trials.

In partial support of Dickerson, et al., Milgram & Noce (1968) reported that relevant verbalization during discrimination learning facilitated performance relative to a no verbalization control which, in turn, was superior to irrelevant verbalization. In addition, irrelevant and relevant verbalization was superior to the control.

Finally, Katz & Rosenberg (1969) required normals and retardates to either associate two (common label condition) or 4 (distinctive label condition) nonsense syllables with four forms during a pretraining period. The results indicated that labeling had no effect on the retardates while discrimination learning was facilitated under the distinctive label condition and inhibited under the common label condition for the normals.

As previously mentioned, in the normal adult literature, RCRs were though to be an important component in VD learning. One strong possibility that may be used to explain differences in learning rates between normals and retardates is that the latter population may be deficient in rehearsal. Ellis (1968) investigated rehearsal strategies in normals and retardates. The apparatus consisted of a horizontal row of nine circles, on a display board, with the tenth circle (probe) in the middle and above the horizontal row. In this setting, Ss were presented with a random series of numbers or letters (projected on to the circles successively from left to right) followed by the probe which was one of the stimuli previously exposed on the horizontal row. The S's task was to identify the position of the number or letter which the probe indicated. Although the first choice was used as the dependent measure, Ss continued to respond until the correct response occurred (signaled by a doorbell chime).

In general the results, using this paradigm with normals, reveal a serial position effect analogous to other short-term memory (STM) tasks with higher recall for primacy followed by recency and finally the middle positions. However, when normals and retardates were compared, on a number of variables, no differences in recall were found for recency, but normals were superior to retardates on primacy and the middle positions. These results were interpreted as indicating a rehearsal deficit in the retardate. If such a deficit exists, then varying the interitem interval should have no effect on recall. In support of this notion, normals and retardates were compared on interitem intervals of 0.0 or 2 sec. with an item exposure duration of 0.5 sec. The results indicated that normals improved in recency with the longer interitem interval while no increase occurred for the retardates.

Ellis (1969) hypothesized that overt rehearsal should differentially effect normals and retardates. According to this view, verbalization of the items for normals should reduce covert rehearsal and therefore depress primacy while recency would increase due to the stronger effect from sensory cues. On the other hand, the primacy effect for retardates should not be effected by verbalization due to the ineffective use of rehearsal strategies while recency should show increases comparable to normals due to the effect from sensory cues. These expectations were not supported: recency increased and primacy decreased for both normals and retardates.

Finally, Gordon & Baumeister (unpublished) reported that retardate performance was facilitated when instructions were given to rehearse (overtly or covertly) the S-R items during the interitem interval in a PA task. Furthermore, the retardate's performance was adversely effected under normal PA instructions. On the other hand, learning in normals was inhibited under instructions to rehearse overtly and performed best under covert rehearsal and standard PA instructions. Apparently, retardates do not utilize rehearsal strategies effectively unless instructed to do so while this type of behavior occurs without instructions in normals.

Denny (1964) hypothesized that retardates were deficient in incidental learning which, in turn, may be due to an attention deficit. In other words, if the retardate distributes his attention over fewer dimensions than the normal, he is less likely to learn the incidental components of any task.

A number of studies have tested the incidental learning deficit hypothesis, using non-verbal tasks, with equivocal findings. When normals and retardates were matched on MA, Hetherington & Banta (1962) reported that normals, organic, and familial retardates were equal on intentional learning. However, the organic retardates were inferior in incidental learning relative to the other two groups although this effect disappeared after an interval of two days. Goldstein & Kass (1961) also found that normals were superior to retardates in incidental learning when both groups were equal on intentional learning.

Baumeister (1963) partially replicated the Hetherington & Banta study using a CA match. In terms of immediate recall, normals were superior to retardates on both intentional and incidental learning. The same relationship was found after two days with the exception that no differences occurred between normals and retardates on the incidental task.

Gardner & Brant (1967) investigated the relationship between motivational variables and intentional-incidental learning in a retarded population. The results indicated that praise, during a serial learning task, increased intentional and incidental learning relative to groups which received no incentive or a prize at the end of learning.

A recent study (Baumeister & Berry, 1968) reported that, in PA learning, context stimuli facilitated normal learning but had no effect on the retardate's performance. According to the authors, context stimuli can be viewed as a type of incidental learning in that Ss were not instructed to utilize these cues in learning.

The results of these studies are difficult to interpret with respect to an incidental learning deficit in the retarded due to the methodological differences between the studies. Furthermore, an incidental learning deficit can only be supported when normals and retardates are equated on intentional learning.

Finally, only study has employed a VD learning task using retardates. Spence (1966) investigated the effects of verbal-reinforcement on retardates using either a right-wrong (RW; E stated right or wrong after S's choice), right-blank (RB; E stated right after the correct response and nothing after the incorrect response), or blank-wrong (BW; E stated wrong after the incorrect response and nothing after the correct response). The results indicated that the RW condition was superior to the other two conditions. Furthermore, instructions explaining the reinforcers had no effect on the retardate's performance.

Proposal

The present study was primarily concerned with the opposed predictions from attention theory (Zeaman & House, 1963) and frequency theory (Ekstrand, Wallace & Underwood, 1966) as they apply to normal children and retardates in a verbal-discrimination (VD) task.

Zeaman & House proposed a two-stage theory to explain normal-retardate differences in discrimination learning. According to the theory, subjects (Ss) must learn a chain of two responses: (1) attending to the relevant stimulus dimensions and (2) making the appropriate instrumental response. The fundamental difference between normals and retardates is assumed to occur in the attention phase: the retardate has a more difficult time in learning to attend to the appropriate stimulus dimensions.

On the other hand, Ekstrand, Wallace & Underwood, in a recent theoretical analysis of VD learning, provided some suggestions that may explain, at least in part, normal-retardate differences in discrimination. The authors postulated that the subjective difference in frequency between the right (R) and wrong (W) words in each pair is the cue used to learn a VD list. The differential accrual of frequency units to the R and W words is assumed to occur as a result of a number of components operating in VD learning: representational responses (RRs) and pronunciation responses (PRs) during the anticipation interval and rehearsal-of-the-correct responses (RCRs) during the feedback interval. The implication from frequency theory is that the retardate may require a larger frequency difference than the normal in order to learn a discrimination.

One of the testable distinctions between the two theories concerns the effects of pretraining on subsequent discrimination learning. Attention theory predicts that pretraining will increase the probability of attending to the relevant stimulus cues. Consequently, if attention theory is applicable to VD learning, increasing the word frequency of both the R and W items should increase the attention value of the words and therefore increase the performance of retardates relative to normals.

On the other hand, frequency theory predicts that pretraining would result in a decrease in performance. This result would be expected, according to an analogy from Weber's law, in that adding frequency units to low frequency pairs would be more discriminable than adding units to high frequency pairs. Furthermore, if the retardate cannot effectively utilize the frequency cue as well as the normal, this inability should be reflected more so in the high frequency condition.

Evidence to support either theory has been equivocal. In non-verbal tasks, pretraining on both the correct and incorrect stimuli facilitated discrimination learning in the retarded (Dickerson, Girardeau & Spradlin, 1964; House, 1964;

Milgram & Noce, 1968). However, in the normal adult VD literature, several studies (Berkowitz, 1968; Lovelace, 1968; Postman, 1962; Underwood & Freund, 1970) have favored an inverse relationship between frequency and learning rate when low and high frequency lists were compared while other studies have reported null effects (Keppel, 1966; Schultz & Hopkins, 1968) or a positive relationship (Runquist & Freeman, 1960; Schultz & Hopkins, 1968).

Pronunciation provides another approach in which attention and frequency may be evaluated in the VD task. There are at least four possible ways in which pronunciation (PR) may be manipulated in the VD task: PR (normal VD)--S pronounces his choice during the anticipation interval; PR (RR)--S pronounces both words and then his choice during the anticipation interval; PR (RCR)--S pronounces his choice during the anticipation interval and pronounces the R item during the feedback interval; and PR (RR-RCR)--S pronounces both words and then his choice during the anticipation interval and pronounces the R item during the feedback interval.

Attention theory would predict faster learning for the PR (RR-RCR) condition since pronunciation during the anticipation and feedback intervals would continuously focus the retardate's attention on the discriminative stimuli. In the PR (RR) and PR (RCR) conditions, an attention deficit may be operative in that the retardate may not be attending to the R and W items during the anticipation interval or attending to the R item in the feedback interval. Finally, the PR condition should produce the largest decrease in the retardate's performance due to the combined effects of not attending to the relevant stimuli during the anticipation and feedback intervals. In contrast, normal children should not be differentially effected by the pronunciation conditions due to the absence of an attention deficit in this population. In summary, attention theory predicts an interaction between pronunciation and intelligence, e.g., the PR condition producing the greatest performance difference in favor of the normals followed by the RR and RCR conditions with normals equal to retardates under the RR-RCR condition. Finally, there may or may not be a performance difference between the two intermediate conditions depending upon the relative importance of attention processes operating in the anticipation and feedback interval.

On the other hand, frequency theory, under the assumption that the RRs, PRs, and RCRs are qualitatively the same, would predict no effect due to pronunciation nor a Pronunciation X Intelligence interaction since the same frequency accrual would occur in each condition.

The VD task may also reflect other processes that may differentiate normals and retardates. During the feedback interval Ss have the opportunity to covertly or overtly rehearse the R item. Adding frequency units via rehearsal would increase the frequency differential and therefore increase VD learning. However, there is some evidence that retardates do not rehearse unless instructed to do so (Ellis, 1968; Gordon & Baumeister, unpublished). Consequently, in the VD task, a rehearsal deficit should reflect decreased performance under the PR and RR conditions relative to the RCR and RR-RCR conditions.

Finally, the VD task may be conceptualized as a Type II learning situation in which intentional and incidental learning occur simultaneously (McLaughlin, 1965). The intentional aspect requires S to recognize and pronounce the R items while the incidental components includes learning the R and W items as responses and learning the associations between the R and W items (Kausler, 1966). Consequently, the VD task provides an appropriate test of the incidental learning hypothesis in the retarded (Denny, 1964). Previous research (Baumeister, 1963; Baumeister & Berry, 1968; Goldstein & Kass, 1961; Hetherington & Banta, 1962) has generally supported an incidental deficit in the retarded although this effect, in a few of the above studies, apparently disappears within a two day retention interval. In the present study, an associative matching task was given immediately after VD learning in order to assess the validity of the incidental learning deficit hypothesis in a VD task.

CHAPTER II

METHOD AND PROCEDURE

Subjects

A sample of 64 retardates will be selected from the Special Education Classes at the Midwest City-Del City Public Schools and randomly assigned to eight treatment conditions. The treatment conditions will not differ with respect to MA, CA or IQ.

A sample of 64 normals of comparable MA to the retardates will be selected from the same school system and randomly assigned to the same eight treatment conditions. The treatment conditions will not differ with respect to MA, CA or IQ.

Finally, all Ss will be naive with respect to past experience in verbal learning research.

Apparatus & Materials

A pool of 36 monosyllable nouns (frequency between 1,000 and 2,000) will be selected from the Thorndike & Lorge (1944) norms for juveniles and used to construct the various lists. In all lists the inter-word associations will be kept to a minimum and word length will range from 3 to 5 letters.

The words will be exposed via a Lafayette memory drum unless otherwise noted.

Procedure

The experiment will be conducted in the following temporal order:

Screening phase. Initially all Ss will pronounce the pool of 36 words. The words will be presented serially for one trial with an exposure rate of 4 sec. The screening trial will be used to exclude Ss that may not be able to adequately pronounce the words.

Pretraining phase. A total of 32 words will be selected from the word pool and used to construct two sixteen word serial lists. The words will be randomly assigned to either list 1 or list 2 with the restriction that an approximate equal number of three, four, and five letter words will appear in both lists. In addition, each list will be arranged in four random serial orders. The lists will be randomly assigned to either a low frequency or high frequency condition. In the low frequency condition, half of the normals and retardates will pronounce words that will not be employed in the VD learning phase. In the high frequency condition the remaining Ss will pronounce words that will later be employed in the VD learning phase. In both conditions Ss will pronounce the words for ten trials with an exposure duration of 2 sec. and intertrial interval of 4 sec.

Demonstration phase. A two pair word list will be constructed from the four remaining words in the word pool and printed on 3 x 5 cards with the word pairs in horizontal alignment. Each S will practice on the list, under one of the four different pronunciation conditions (described below), via E presentation until S is judged to understand the nature of the task.

VD learning phase. The VD list will be composed of eight pairs of words that were previously employed in the high frequency condition in the pretraining phase. The list will be arranged in four random serial orders with the left-right spatial position of each pair randomized within each serial order. In addition, successive spatial position for any word will be limited to three. Each word pair will be juxtaposed and presented via the anticipation method at a 4:4 sec. rate with an 8 sec. intertrial interval. Normals and retardates will be instructed to learn the VD list under one of the following conditions: PR (normal VD); PR (RR); PR (RCR); and PR (RR-RCR). Learning will be carried to one perfect trial or 15 trials whichever comes first. Furthermore, Ss will not be informed about the relationship between pretraining and VD learning.

Associative learning phase. Immediately following VD learning all Ss will receive an associative matching task (AMT). The R and W words will be presented on paper in different columns and S will be instructed to draw a line between the words that were originally paired in the VD task. The words in each column will be randomized with respect to serial position. Finally, no time limits will be set for AMT.

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APPENDIX B

RETARDATE MA, CA, AND IQ

RETARDATE MA, CA, AND IQ

MA (MONTHS)

LOW FREQUENCY				HIGH FREQUENCY			
PR	RR	RCR	RR-RCR	PR	RR	RCR	RR-RCR
130	104	110	96	98	94	90	112
87	84	106	123	150	76	116	122
124	106	114	99	144	138	116	104
114	120	133	92	100	78	74	120
128	120	138	136	66	115	114	110
82	98	120	110	116	84	137	110
112	140	110	122	110	128	140	98
82	130	106	128	114	122	116	102

CA (MONTHS)

LOW FREQUENCY				HIGH FREQUENCY			
PR	RR	RCR	RR-RCR	PR	RR	RCR	RR-RCR
144	160	162	196	191	193	150	156
186	137	208	172	228	154	161	218
197	162	189	176	222	185	160	163
206	199	171	225	156	221	107	209
173	169	169	182	85	166	192	161
192	206	227	190	159	179	190	172
156	217	165	165	189	193	224	146
120	209	151	180	205	166	206	142

IQ

LOW FREQUENCY				HIGH FREQUENCY			
PR	RR	RCR	RR-RCR	PR	RR	RCR	RR-RCR
90	65	71	50	54	50	63	72
51	64	55	75	78	54	75	63
65	69	60	60	75	78	73	64
59	63	77	46	67	40	62	63
78	74	84	75	75	74	60	68
45	55	55	58	75	52	70	64
78	74	70	74	62	69	73	70
76	63	73	73	57	76	60	79

APPENDIX C

NORMAL MA, CA, AND IQ

NORMAL MA, CA, AND IQ

MA (MONTHS)

LOW FREQUENCY				HIGH FREQUENCY			
PR	RR	RCR	RR-RCR	PR	RR	RCR	RR-RCR
92	89	92	93	85	72	84	82
99	88	96	96	133	79	81	101
147	110	114	111	104	80	87	116
100	98	105	134	108	114	112	105
111	118	109	79	82	121	111	130
108	101	162	141	97	92	116	125
105	149	137	109	124	153	147	112
119	112	125	132	114	122	144	129

CA (MONTHS)

LOW FREQUENCY				HIGH FREQUENCY			
PR	RR	RCR	RR-RCR	PR	RR	RCR	RR-RCR
101	91	101	88	128	79	81	98
89	89	89	93	85	72	84	82
116	105	111	117	110	85	91	109
106	106	105	121	96	101	112	109
119	113	114	79	82	112	96	111
109	99	134	142	105	100	110	118
111	133	133	118	114	138	141	117
113	118	125	113	111	120	137	117

IQ

LOW FREQUENCY				HIGH FREQUENCY			
PR	RR	RCR	RR-RCR	PR	RR	RCR	RR-RCR
102	100	103	98	100	100	100	100
98	95	92	109	101	100	100	102
123	105	100	96	96	94	94	107
95	93	102	107	111	107	100	94
91	101	93	100	100	110	114	114
96	100	117	98	92	93	108	103
92	109	101	91	106	108	102	93
102	93	98	113	100	102	103	107

APPENDIX D

TRIALS TO CRITERION

TRIALS TO CRITERION

NORMALS

	LOW FREQUENCY				HIGH FREQUENCY			
	PR	RR	RCR	RR-RCR	PR	RR	RCR	RR-RCR
	4	15	5	5	5	5	5	4
	6	8	5	5	3	8	4	15
	2	8	5	8	15	12	7	5
	3	9	3	9	5	10	8	10
	4	7	7	4	4	11	9	9
	9	14	9	15	7	4	8	6
	5	6	6	5	2	12	15	9
	5	5	3	2	3	14	5	10
M =	4.75	9.00	5.38	6.62	5.50	9.50	7.62	8.50
SD=	2.12	3.62	2.00	4.03	4.14	3.54	3.46	3.50

RETARDATES

	LOW FREQUENCY				HIGH FREQUENCY			
	PR	RR	RCR	RR-RCR	PR	RR	RCR	RR-RCR
	4	3	8	5	8	8	3	5
	15	15	6	4	15	6	15	8
	4	15	14	6	9	7	15	6
	4	12	3	7	4	7	15	4
	9	8	5	13	2	8	5	4
	2	9	3	5	15	7	8	9
	5	8	11	15	4	15	15	8
	6	15	6	6	15	15	15	10
M =	6.12	10.62	7.00	7.62	9.00	9.12	11.38	6.75
SD=	4.12	4.37	3.85	4.07	5.45	3.68	5.18	2.31

APPENDIX E

ERRORS TO CRITERION

ERRORS TO CRITERION

NORMALS

	LOW FREQUENCY				HIGH FREQUENCY			
	PR	RR	RCR	RR-RCR	PR	RR	RCR	RR-RCR
	12	45	11	13	7	13	15	6
	13	22	14	11	6	13	11	68
	4	23	12	32	29	28	21	8
	4	33	8	30	11	33	16	39
	8	11	10	9	9	27	14	11
	16	33	17	61	14	6	17	14
	8	13	15	11	6	35	67	24
	7	10	5	2	9	33	13	35
M =	9.00	23.75	11.50	21.12	11.37	23.50	21.75	25.62
SD=	4.30	12.49	3.89	19.16	7.61	11.16	18.52	21.07

RETARDATES

	LOW FREQUENCY				HIGH FREQUENCY			
	PR	RR	RCR	RR-RCR	PR	RR	RCR	RR-RCR
	8	8	21	12	17	18	8	16
	8	25	31	10	27	21	60	8
	40	48	6	9	40	12	53	19
	7	17	8	18	10	20	49	13
	3	22	15	27	48	16	12	7
	6	19	27	8	7	16	17	19
	29	24	9	53	70	60	45	20
	13	56	6	12	5	59	57	30
M =	14.25	27.37	15.37	18.62	28.00	27.75	37.62	16.50
SD=	13.13	16.22	9.86	15.21	23.06	19.78	21.56	7.38

APPENDIX F

ERRORS OVER THE FIRST FIVE TRIALS

ERRORS OVER THE FIRST FIVE TRIALS

NORMALS

	LOW FREQUENCY				HIGH FREQUENCY			
	PR	RR	RCR	RR-RCR	PR	RR	RCR	RR-RCR
	12	18	11	13	7	13	15	6
	13	17	14	11	6	9	11	24
	4	21	12	27	15	15	19	8
	4	27	8	18	11	20	14	19
	8	10	9	9	9	16	11	7
	12	18	13	24	13	6	15	14
	8	13	15	11	6	20	22	20
	7	10	5	2	9	20	13	21
M =	8.50	16.75	10.87	14.37	9.50	14.87	15.00	14.87
SC=	3.54	5.75	3.35	8.21	3.29	5.30	3.81	7.10

RETARDATES

	LOW FREQUENCY				HIGH FREQUENCY			
	PR	RR	RCR	RR-RCR	PR	RR	RCR	RR-RCR
	8	5	21	12	14	18	8	13
	8	11	14	10	16	17	12	8
	19	21	6	9	21	11	15	19
	7	13	8	17	10	18	20	13
	3	14	13	17	22	14	21	7
	6	16	16	8	7	13	17	15
	16	16	9	21	28	20	23	15
	13	21	6	12	5	19	14	18
M =	10.00	14.62	11.62	13.25	15.37	16.25	16.25	13.50
SD=	5.45	5.26	5.31	4.59	7.96	3.19	5.00	4.27

APPENDIX G

ASSOCIATIVE MATCHING SCORES

ASSOCIATIVE MATCHING SCORES

NORMALS

	LOW FREQUENCY				HIGH FREQUENCY			
	PR	RR	RCR	RR-RCR	PR	RR	RCR	RR-RCR
	1	3	1	4	2	4	0	3
	8	6	2	2	6	1	1	2
	1	4	2	1	6	4	5	3
	1	1	1	1	0	0	1	1
	1	4	6	2	4	0	8	1
	6	0	3	5	2	3	3	5
	2	6	1	1	0	3	1	1
	2	5	5	0	8	4	0	4
M =	2.75	3.62	2.62	2.00	3.50	2.38	2.38	2.50
SD=	2.71	2.20	1.92	1.69	2.98	1.77	2.82	1.51

RETARDATES

	LOW FREQUENCY				HIGH FREQUENCY			
	PR	RR	RCR	RR-RCR	PR	RR	RCR	RR-RCR
	1	1	4	1	5	0	5	0
	4	4	2	6	2	0	3	1
	6	8	1	3	2	8	1	3
	1	0	1	2	3	2	5	6
	0	8	2	2	4	0	4	2
	4	5	3	8	2	3	6	3
	4	0	2	3	3	6	1	1
	0	2	3	0	8	2	0	4
M =	2.50	3.50	2.25	3.12	3.62	2.62	3.12	2.50
SD=	2.27	3.30	1.04	2.64	2.06	2.97	2.23	1.93

APPENDIX H

PEARSON PRODUCT MOMENT CORRELATIONS BETWEEN TRIALS TO CRITERION AND ASSOCIATIVE MATCHING SCORES

PEARSON PRODUCT MOMENT CORRELATIONS BETWEEN TRIALS TO CRITERION AND ASSOCIATIVE MATCHING SCORES

NORMALS

LOW FREQUENCY				HIGH FREQUENCY			
PR	RR	RCR	RR-RCR	PR	RR	RCR	RR-RCR
.78	-.68	.19	.61	.21	-.01	.19	-.40

RETARDATES

LOW FREQUENCY				HIGH FREQUENCY			
PR	RR	RCR	RR-RCR	PR	RR	RCR	RR-RCR
-.04	.24	-.21	-.25	.11	.25	-.63	-.06

APPENDIX I

VD WORD LIST

VD WORD LIST

R	W
PLAN	CAR
WALL	SENSE
SIDE	PRICE
CHAIR	HEART
AGE	MILE
STATE	FRONT
WALL	STEP
FACT	TEN

APPENDIX J

PRETRAINING WORD LISTS

PRETRAINING WORD LISTS

RELEVANT SERIAL LIST (HIGH FREQUENCY CONDITION)	IRRELEVANT SERIAL LIST (LOW FREQUENCY CONDITION)
SIDE	POINT
AGE	END
TEN	TOWN
CAR	SOUND
WALL	BED
PRICE	FORCE
HEART	STAND
CHAIR	DRESS
MILE	CUP
STEP	LINE
SENSE	LOT
FACT	MONTH
VOICE	PART
PLAN	NAME
FRONT	FIRE
STATE	BOY

APPENDIX K

DEMONSTRATION WORD LIST

DEMONSTRATION WORD LIST

R	W
TRAIN	COOK
FEET	PAINT

APPENDIX L

ASSOCIATIVE MATCHING TASK

ASSOCIATIVE MATCHING TASK

Listed below are the right and wrong items which have appeared in the list. Your task is to repair the words as they appeared in the original list by drawing a line between the right and wrong words.

VOICE	HEART
WALL	PRICE
SIDE	MILE
CHAIR	CAR
FACT	STEP
STATE	FRONT
PLAN	SENSE
AGE	TEN

APPENDIX M

INSTRUCTIONS

INSTRUCTIONS

Screening Instructions

In the window of this memory drum you will see words presented at four-second intervals. Your task is to pronounce each word as it appears.

Pretraining Instructions

In the window of this memory drum you will see words presented at two-second intervals. Your task is to pronounce each word as it appears.

VD Instructions

In the window of this memory drum pairs of words will be presented at four-second intervals. One of the words in each pair has been arbitrarily designated as "right," and the other as "wrong." Each pair will be exposed twice, for four seconds each time, before a new pair appears.

NVD Instructions--Your task is to learn to recognize and pronounce the word designated as "right" during the first exposure of each pair. The second exposure, in which the "right" word will be underlined, will inform you whether or not your selection was correct.

RR Instructions--Your task is to pronounce both words, then learn to recognize and pronounce the word designated as "right" during the first exposure of each pair. The second exposure, in which the "right" word will be underlined, will inform you whether or not your selection was correct.

RCR Instructions--Your task is to learn to recognize and pronounce the word designated as "right" during the first exposure of each pair. Furthermore, during the second exposure, your task is to pronounce the "right" word which will be the underlined word. This will inform you whether or not your selection was correct.

RR-RCR Instructions--Your task is to pronounce both words, then learn to recognize and pronounce the word designated as "right" during the first exposure of each pair. Furthermore, during the second exposure, your task is to pronounce the "right" word which will be the underlined word. This will inform you whether or not your selection was correct.

There are eight different pairs in the list. Each time through the eight pairs constitutes a "trial." Two asterisks will appear in the window within the eight-second interval between trials to cue you that a new trial will follow in four seconds. The eight pairs of words are rearranged in four different orders so that the position and order of "right" and "wrong" words will vary within each trial to eliminate any responses that might have been based on serial or position cues. Your first trial will be a "guessing" trial--guess which word you think is "right" during the first exposure of each pair. You will continue the trials until you make no mistakes. To clarify any questions, we will first practice on a few words unrelated to the formal learning task.

APPENDIX N

ANOVAS

ANOVAS

Errors Over the First Five Trials

SOURCE	SS	DF	MEAN SQ	F-RATIO
A (Intelligence)	18.757	1	18.757	0.663
B (Pronunciation)	378.335	3	126.111	4.463
C (Frequency)	122.070	1	122.070	4.320
AB	111.648	3	37.216	1.317
AC	33.007	1	33.007	1.168
BC	113.585	3	37.861	1.340
ABC	30.398	3	10.132	0.358
ERROR	3164.125	112	28.251	
TOTAL	3971.93	127		

Errors to Criterion

SOURCE	SS	DF	MEAN SQ	F-RATIO
A (Intelligence)	717.257	1	717.257	3.072
B (Pronunciation)	1604.086	3	534.695	2.290
C (Frequency)	1306.883	1	1306.883	5.598
AB	1414.211	3	471.403	2.019
AC	150.945	1	150.945	0.646
BC	1336.961	3	445.653	1.909
ABC	484.398	3	161.466	0.691
ERROR	26146.128	112	233.447	
TOTAL	33160.87	127		

Trials to Criterion

SOURCE	SS	DF	MEAN SQ	F-RATIO
A (Intelligence)	57.781	1	57.781	3.936
B (Pronunciation)	173.062	3	57.687	3.930
C (Frequency)	52.531	1	52.531	3.578
AB	51.781	3	17.260	1.175
AC	0.125	1	0.125	0.008
BC	65.531	3	21.843	1.488
ABC	41.062	3	13.687	0.932
ERROR	1644.000	112	14.678	
TOTAL	2085.87	127		

Associative Matching

SOURCE	SS	DF	MEAN SQ	F-RATIO
A (Intelligence)	1.125	1	1.125	0.207
B (Pronunciation)	8.125	3	2.708	0.498
C (Frequency)	0.031	1	0.031	0.005
AB	1.750	3	0.583	0.107
AC	0.281	1	0.281	0.051
BC	16.843	3	5.614	1.034
ABC	5.343	3	1.781	0.328
ERROR	608.000	112	5.428	
TOTAL	641.50	127		

Mixed-Effects Analysis of Variance

SOURCE	SS	DF	MEAN SQ	F-RATIO
Between Ss	784.79	127		
A (Intelligence)	5.81	1	5.81	0.96
B (Frequency)	21.19	1	21.19	3.49
AB	5.53	1	5.53	0.91
Between Error	752.26	124	6.06	
Within Ss	1296.40	512		
C (Trials)	543.15	4	135.78	93.64
AC	14.05	4	3.51	2.42
BC	16.52	4	4.13	2.84
ABC	0.90	4	0.22	0.15
Within Error	721.78	496	1.45	
TOTAL	2081.19	639		