Inter-item manipulations of implicit associative responses in verbal-discrimination learning¹

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Two experiments were performed to test predictions from frequency theory regarding the role of implicit associative responses (IARs) in verbal-discrimination learning. Although list content was demonstrated to limit generalization, a list employing associatively related right (R) items and unrelated wrong (W) items was consistently found to be most difficult, while lists composed of associatively related wrong (W) items tended to be learned most readily. These results fail to replicate the findings of Ekstrand, Wallace, & Underwood (1966) and are inconsistent with the frequency theory. Methodological variables having possible implications for the obtained results were suggested for further investigation.

The frequency theory (Ekstrand, Wallace, & Underwood, 1966) of verbal-discrimination (VD) learning postulates that learning a single list of unrelated word pairs is based upon the cue provided by the differential frequency unit accrual between the wrong (W) and right (R) items. The assumed primary sources of differential frequency unit accrual are: representational responses (RRs), pronunciation responses (PRs), and rehearsal of the correct response (RCRs). The theory also assigns a critical role to implicit associative responses (IARs; Bousfield, Witmarsh, & Danick, 1958) whenever W and/or R items are associatively related.

Eberlein & Raskin (1968) and Fulkerson & Kausler (1969) have studied two types of IAR manipulations for which frequency theory predicts interference effects. In both studies, frequency theory was supported when IARs were exchanged between W and R items of different pairs (i.e., an interpair manipulation). Such lists were more difficult to learn than a control list of unrelated pairs. Contrary to frequency theory, however, both studies found an intrapair condition (i.e., high bidirectional associates formed a given pair) to be no more difficult than the control list.

Frequency theory also predicts that transfer of IARs in a list involving associatively related R items and unrelated W items (AR condition) will facilitate acquisition by increasing the differential

frequency cue relative to a control (C) list of unrelated W and R items. Ekstrand et al found support for this predicted facilitation in their AR condition, but the AW condition (related W items and unrelated R items) failed to be significantly inferior to the C condition. The present study was designed to test further the predicted roles of IARs in such interitem manipulations under methodological conditions that differ considerably from those employed by Ekstrand et al. Individual learning sessions and the anticipation method were employed rather than group sessions and the study-test method. Visual presentation and an initial guessing trial were utilized as compared to auditory presentation and no-guessing trial. And finally, the present experiment employed a 14-pair list with a 2:2-sec rate of exposure as opposed to a 20-pair list and a 3:3-sec exposure rate.

In addition to the C, AR, and AW conditions, a condition not previously investigated was employed in which the interitem associative manipulation occurred in both the W and R items (AW-AR). Table 1 presents an illustration of the assumed distribution of frequency units to the W and R items in each condition (cf. Ekstrand et al, 1966). Table 1 indicates that the differential frequency unit accrual for W and R items, respectively, in the C and AW-AR conditions is identical. Hence, according to differential frequency cue theory, these conditions should not differ in difficulty of acquisition. The AR and AW conditions, however, should be superior and inferior, respectively, to the C and AW-AR conditions, according to the differential frequency cues involved.

EXPERIMENT 1

Subjects

Fifty-six introductory psychology students were assigned randomly to each of the four conditions (N = 14) under the restriction that a given block of n conditions be fully represented before assigning the n + 1 cell. All Ss were naive to

Table 1
Theoretical Distributions of Frequency Units

Groups	C	AR	AW	AW-AR
Frequency Unit				
RR	1 1	1 1	1 1	1 1
PR	- 1	- 1	- 1	- 1
RCR	- 1	- 1	- 1	- 1
IAR	- -	- 1	1 -	1 1
Total	1:3	1:4	2:3	2:4

verbal-learning research and participated voluntarily.

Word Lists and Procedures

Twenty-eight primary words were chosen from the Palermo & Jenkins (1964) norms on the basis of minimal or neutral associative relatedness to one another. For each of the 28 unrelated primary words, the highest associate was selected for possible AR or AW word function, with the restriction that such words be associatively unrelated to each other and related to only one primary word.

Fourteen neutral primary words were selected randomly to serve as W items, while the remaining 14 became the R items. The C list was formed by pairing the primary W and R items randomly. The items for the AW-AR list were generated by selecting randomly seven W and seven R items from the C list and adding the highest associate for each word. Random pairings of the 14 W and R items were then constructed. The AR list was composed of the 14 primary W words from the C list and the 14 R words from the AW-AR list. Similarly, the AW list consisted of the 14 W items from the AW-AR list and the 14 primary R words from the C list. The mean percentages of associative frequency for the W and R item associates were 44% and 46%, respectively.

Each list was arranged in four random serial orders to control for serial-position effects. Left-right R-item spatial position was also independently randomized within each serial order, with successive runs of a given spatial position limited to three. Across the four random serial orders, a given R item appeared twice on each side.

Standard VD instructions were read to each S, but no information was given regarding the nature of the list composition. The lists were presented by the anticipation method, on a Lafayette memory drum, at a 2:2-sec rate with a 4-sec intertrial interval. The W-R pair appeared contiguously in a horizontal alignment during both exposures, with the R item underlined during the feedback exposure. Following an initial guessing trial, practice was carried to a criterion of two consecutive errorless trials.

Results and Discussion

The statistical analyses reported below are based on transformed error scores (i.e., $\sqrt{X} + \sqrt{X + 1}$), which successfully eliminated heterogeneity of variance. A 2 by 2 factorial analysis of variance (W or R item function in combination with associative relationship, i.e., related vs unrelated) yielded only a significant W item main effect [$F(1,52) = 4.93$, $p < .05$]. Contrary to frequency theory, the AW and AW-AR lists resulted in fewer errors (transformed $\bar{X} = 9.51$) than did the

AR and C lists ($\bar{X} = 11.28$). The transformed group means were 9.20 (AW), 9.82 (AW-AR), 10.28 (C), and 12.28 (AR). In a comparison of all pairs of means, Duncan's test indicated that only the AW vs AR comparison reached significance ($p < .05$).

To obtain greater comparability with the results reported by Ekstrand et al, which represent errors over only four trials, an analysis was also conducted on the number of errors for Trials 2-5. (The initial guessing-trial data were excluded since Ekstrand et al used a study-test procedure.) Contrary to the analysis on total errors, the W item effect was nonsignificant ($p > .05$), whereas an R item effect was present [$F(1,52) = 4.74, p < .05$]. In opposition to frequency theory, the AR and AW-AR lists (raw score $\bar{X} = 16.35$) were more difficult on the early trials than were the AW and C conditions ($\bar{X} = 12.35$). The group means, based on raw scores, were 11.21 (AW), 13.50 (C), 14.43 (AW-AR), and 18.28 (AR). In agreement with the total errors analysis, only the AW vs AR means differed significantly ($p < .05$, Duncan's test). The superiority of the AW condition over the AR condition in both analyses is inconsistent with the frequency theory and also is at variance with the results reported by Ekstrand et al. In both analyses, however, neither condition differed significantly from the C condition.

EXPERIMENT 2

It is conceivable that the discrepancies between the theoretically derived predictions and the results of Experiment 1 might be attributable to the particular word-pairings employed. Experiment 2, therefore, utilized two sets of word-pairings to test the generality of the findings of Experiment 1. A new pool of 28 unrelated primary words and their highest associates was selected from the Palermo and Jenkins norms. One set (Set A) of four experimental lists was formed by the procedures enumerated for list construction in Experiment 1. A second set (Set B) was formed for each condition by re-pairing randomly the W and R combinations of Set A. All other details of list construction and experimental procedure were identical to those of Experiment 1, except that learning was carried to only one perfect trial. Twelve Ss were assigned randomly to each of the eight conditions created by the four treatment conditions and the two list sets ($N = 96$).

Results and Discussion

The group means for total errors were as follows: Set A—26.00 (AW), 27.50 (AW-AR), 41.33 (C), and 43.17 (AR); Set B—19.33 (C), 27.83 (AW-AR), 35.50 (AW), and 39.08 (AR). The square-root

transformation was again utilized to eliminate heterogeneity of variance. Although the analysis of variance indicated a significant W item effect [$F(1,88) = 4.16, p < .05$], significant interactions involving the W item by R item associative relationship, the W item relationship by list set, and a second-order interaction mitigate a simple interpretation of this main effect.

The above interactions necessitated separate between-group analyses of variance for each list set. The resulting error terms were utilized to compare group means via Duncan's test. In List Set A, the only significant difference was in the inferiority of the AR condition to the AW and AW-AR conditions (both $ps < .05$). For List Set B, the AR and AW conditions were inferior to the C condition (both $ps < .01$). The AR condition was also significantly inferior to the AW-AR condition ($p < .05$). The failure to obtain a difference between the AR and AW conditions is inconsistent with the results of List Set A and Experiment 1. The equality of the C and AW-AR conditions and the pronounced difficulty of the AR condition was consistent, however, across both studies.

The mean errors over Trials 2-5 for each group were: Set A—11.58 (AW-AR), 12.50 (AW), 15.42 (C), and 17.00 (AR); Set B—10.00 (C), 13.58 (AW-AR), 16.58 (AW), and 17.00 (AR). Although no significant main effects were obtained, the interactions involving W item by R item associative relationship and W item relationship by list sets reached significance (both $ps < .025$). Separate analyses were therefore conducted within each list set, as in the analysis for total errors. The group means of Set A did not differ significantly. As was true in the analysis on total errors, however, the AR and AW conditions of List Set B were inferior to the C condition (both $ps < .05$).

When contrasted with the data from Experiment 1, the results of Experiment 2 suggest that list content and/or word pairings may be critical in determining not only the extent of facilitation or interference produced by those factors, but also the point in learning at which such processes are evoked. This conclusion is based upon the differential rank orders of the conditions across list sets and the disparity in results between the analyses of total errors and errors on Trials 2-5.

DISCUSSION

The two experiments found consistent support for frequency theory in its prediction of a null difference, based on the differential frequency cues involved, for the AW-AR and C conditions. The failure to demonstrate significantly greater difficulty for the AW condition relative to

the control list on two of the three analyses of total errors is consistent with the empirical data reported by Ekstrand et al (1966) but inconsistent with the frequency theory. The same conclusion may be drawn from the analyses of errors on Trials 2-5. Further, the finding that the AR condition consistently ranked as the most difficult in all analyses is in direct opposition to theoretically derived predictions and to the findings of Ekstrand et al. Indeed, the AR condition was even significantly inferior to the AW condition in both error score analyses of Experiment 1. In Experiment 2, this difference reached significance only in the comparison of total errors on List Set A. However, the AR condition was even more difficult than the control list in the analyses of total errors and errors over Trials 2-5 on List Set B.

The discrepancies between the present results and both the predictions from the theory and the data reported by Ekstrand et al suggest that future experiments designed to study the role of IARs in VD learning should utilize counterbalanced controls for item function as well as variation of item pairings. Although Experiment 2 varied item pairing, the lack of counterbalancing of item function makes it impossible to conclude whether or not item pairing was alone responsible for the variance in the results between List Set A and B. It is conceivable that with the utilization of meaningful words, item function and pairing may both interact as factors affecting the influence of IARs in VD learning. Although Ekstrand et al did balance item function, the generality of their findings across sets of word-pairings was not tested.

The consistent pronounced difficulty of the AR condition across both experiments is contrary to both the theory and the previous empirical data (Ekstrand et al). This finding suggests that methodological factors in addition to item function and item pairing may have important implications for IAR utilization in VD learning. Further study may be warranted, for example, of the effects of the anticipation method vs the study-test procedure, an initial guessing trial vs its absence, length of list, rate of exposure, and instructions regarding list content. In general, the role of methodological variables in VD learning has been a neglected area of investigation.

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NOTE

1. Experiment 1 of the present study is based, in part, upon a Master's thesis submitted to the University of Oklahoma by the third author. A paper based upon the present experiments was read at the annual meeting of the Southwestern Psychological Association, Austin, Texas, 1969.

Cardiac responses to attended and ignored stimuli

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Heart-rate measures were taken on grade-school children induced to attend to, ignore, or make judgments about passively presented tactile stimuli. Some evidence was found for differential cardiac responses to attended and ignored stimuli, with relative heart-rate deceleration to attended stimuli, even though the attended and ignored stimuli were physically identical. The positive evidence was found, however, only under the experimental condition that would be expected to induce S to make the greatest attempt to ignore the stimuli he was asked to ignore.

Lacey (Lacey, 1959; Lacey, Kagan, Lacey, & Moss, 1963) has suggested that attention to the external environment is associated with heart-rate (HR) decrease, and that conditions that provoke "rejection" of external stimuli are associated with HR increase. The experiments that produced the basic data to support these claims confounded an S's attentional state with the particular physical stimuli presented during presumed states of attention to or rejection of the external environment. Some stimuli that were assumed to elicit attention (colored slides, flashing lights, etc.) produced HR decrease over a period of time, while other tasks (mental arithmetic, etc.) assumed to

demand rejection of the external environment produced HR increase (Lacey et al, 1963; Obrist, 1963).

The present study was designed to obtain some evidence that rapid, short-term changes in HR are associated with an S's attentional state, when the physical stimuli are held constant across states of attention to and rejection of the environment. The experiment used a recognition-memory technique in which Ss were expected to attend to some relevant stimuli in order to remember them and to ignore other irrelevant stimuli to prevent them from interfering with memory.

METHOD

Twenty-four Ss, 11 to 14 years old, participated in the experiment. Each S received two practice trials, followed by 32 test trials. Each trial consisted of the sequential presentation of three colored lights (blue, green, yellow) combined with tactile stimuli. Each light was presented for 8 sec, and a tactile stimulus was presented during the last 6 sec of each light. A trial terminated with S's verbal judgment (described below) about the spacing of discrete points in the tactile stimuli.

Each tactile stimulus consisted of two or three metal rods, 1 mm in diam, mounted vertically on a small wooden board. The tips of the rods on a board could be pressed against the palm of S's hand. Sixteen stimulus boards were constructed, on eight of which two rods were mounted in a straight line, and on eight of which three rods were mounted in an equilateral triangle. The spacings between the rods

ranged from 10 to 45 mm in 5-mm steps.

On each trial, S received one tactile stimulus to which he was instructed to attend (the "attend" stimulus), one that he was instructed to ignore (the "ignore" stimulus), and one (the "judge" stimulus) that he was to compare in spacing with the attend stimulus. Prior to the experiment, S was told that the signal light associated with each stimulus would indicate whether he was supposed to attend to, ignore, or judge the stimulus. He was told which color indicated "attend," "ignore," or "judge" and was urged to attend to the attend stimulus and ignore the ignore stimulus.

On each trial, the judge stimulus was presented last, and S verbally indicated whether or not he thought it was the same in spacing as the attend stimulus. On half the trials (the AIJ, attend-ignore-judge trials), the attend stimulus preceded the ignore stimulus. On the remaining trials (the IAJ trials), the ignore stimulus preceded the attend stimulus. On each trial, the attend and judge stimuli had the same number of rods, while the ignore stimulus had a different number.

On half the trials, the judge stimulus was the same in spacing as the attend stimulus, while on the remaining trials, they differed by 10 mm. The ignore stimulus differed by at least 5 mm from the other stimuli. Counterbalancing procedures were used that ensured that the AIJ-IAJ (trial-type) variable and the correct size judgment (same-different) were not confounded with trial number, and thus with practice or fatigue effects. Further counterbalancing was used to ensure that each tactile stimulus occurred equally often as an attend, an ignore, and a judge stimulus for each S, and that, over all Ss, each signal-light color and position was assigned equally often to each "meaning."

The S's right arm extended through a curtained hole in a vertical panel in front of which he was seated. A motorized device was used to press the tactile stimuli against the palm of his right hand, which was held immobile on a horizontal shelf. Three Christmas-tree bulbs, mounted on the vertical panel above S's right arm, served as signal lights. Heart rate was recorded by a Fels cardiograph and a Hewlett-Packard counterprinter, which printed out each successive R-R interval in milliseconds. Skin conductance measures, not reported here, were also taken.

RESULTS

The Ss performed adequately on the judgment task. The overall mean percentage correct judgments was 71% (63% correct on AIJ trials, 79% on IAJ trials). No S performed worse than would be expected by random guessing—16