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AUTHOR	Wilder, Larry
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ABSTRACT

The frequency theory of verbal discrimination learning makes no distinction between silent and spoken rehearsal. Further, the frequency theory predicts that the study-test method of list presentation is superior to the anticipation method. College students, performing under silent and spoken rehearsal conditions, learned 16 low-frequency word-pairs with the anticipation or the study-test method. It was found that spoken rehearsal was superior to silent rehearsal, and that method of presentation was not significant. However, in the spoken rehearsal conditions, a trend toward the predicted differences between the two presentation methods was observed. It was suggested that these findings indicate that spoken rehearsal insures the rehearsal of the correct response, and that silent rehearsers probably do not silently pronounce the correct response to themselves. Implications for the role of spoken rehearsal in verbal discrimination learning were discussed. (For related document, see PS 005 425.) (Author)

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Spoken Rehearsal and Verbal Discrimination Learning

By Larry Wilder

Report from the Project on Variables and Processes in Cognitive Learning

Project Investigators: Herbert J. Klausmeier, Robert E. Davidson, Joel R. Levin, Thomas A. Romberg, B. Robert Tabachnick, Alan M. Voelker, Larry Wilder, Peter Wolff
Technical Development Section Director: Mary R. Quilling
Research Associate: Dorothy A. Frayer

Wisconsin Research and Development Center for Cognitive Learning
The University of Wisconsin
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The Wisconsin Research and Development Center for Cognitive Learning focuses on contributing to a better understanding of cognitive learning by children and youth and to the improvement of related educational practices. The strategy for research and development is comprehensive. It includes basic research to generate new knowledge about the conditions and processes of learning and about the processes of instruction, and the subsequent development of research-based instructional materials, many of which are designed for use by teachers and others for use by students. These materials are tested and refined in school settings. Throughout these operations behavioral scientists, curriculum experts, academic scholars, and school people interact, insuring that the results of Center activities are based soundly on knowledge of subject matter and cognitive learning and that they are applied to the improvement of educational practice.

This Working Paper is from the Project on Variables and Processes in Cognitive Learning in Program 1, Conditions and Processes of Learning. General objectives of the Program are to generate knowledge and develop general taxonomies, models, or theories of cognitive learning, and to utilize the knowledge in the development of curriculum materials and procedures. Contributing to these Program objectives, this project has three objectives: to ascertain the important variables in cognitive learning and to apply relevant knowledge to the development of instructional materials and to the programming of instruction for individual students; to clarify the basic processes and abilities involved in concept learning; and to develop a system of individually guided motivation for use in the elementary school.

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It was found that spoken rehearsal was superior to silent rehearsal, and that method of presentation was not significant. However, in the spoken rehearsal condition, a trend toward the predicted differences between the two presentation methods was observed. It was suggested that these findings indicate that spoken rehearsal insures the rehearsal of the correct response, and that silent rehearsers probably do not silently pronounce the correct response to themselves. Implications for the role of spoken rehearsal in verbal discrimination learning were discussed.

I

INTRODUCTION

For at least 2,000 years it has been suggested that human thinking is directly related to speech (Humphrey, 1963). This intuitively appealing notion achieved prominance in Watson's (1930) subvocal speech theory of thinking. Watson's theoretical position was central to a number of early investigations which concluded that saying lists of verbal materials produces better retention than does silent reading of the same lists (e.g., Hollingsworth, 1935; Underwood, 1964). Recently, interest in subvocal speech has been revived in the literature on human information processing (Neisser, 1967). In this literature, however, the speech response is not limited to subvocal muscular movements. While subjects still are required to pronounce lists of verbal materials, there is seldom any direct reference to this speech behavior. The more common terminology for the speech response is "articulatory coding," "overt rehearsal," "Auxiliary activity," and so on.

Within this broader perspective, however, it is often difficult to determine whether the speech response as an overt verbal act is of theoretical importance, or whether the subject's speech is merely a convenient index of covert verbal processes. In short, many current studies emphasizing the role of "verbalization" in learning are unclear concerning the role of overt speech in the processing of verbal information. Further, studies emphasizing overt verbalization often have failed to specify when during the learning process such speech is most beneficial.

Verbal discrimination learning (VDL) paradigms are particularly useful for the study of speech processes and learning. In the typical VDL experiment, the subject is presented with a list of paired words with one word in each pair arbitrarily designated as "correct" by the experimenter. The subject's task is to choose the correct item of each pair a predetermined number of times in succession without making a mistake (typically, one, two, or three trials). The subject can be given study trials (trials in which the pair is presented with the correct word underlined), or he can begin by guessing which word in the pair is correct (anticipation method). With both methods, the test trials consist of showing the subject the two items, having him choose which item is correct, and informing him whether or not his choice was correct (usually by displaying the same two items again with the correct word underlined).

This comparatively simple paradigm can be tightly controlled in an experimental setting. For instance, the time spent viewing each word-pair can be predetermined, and the subject's rehearsal time (i.e., seeing the correct word underlined) can also be controlled. It is hoped that this kind of rigid control, coupled with the systematic manipulation of experimental variables, will lead to results that can be generalized to "real-world" learning situations. Although many studies indicate the importance of variables such as the length of the list to be learned, the manner in which the items in a pair are associated, the familiarity of the items in a list, and so on, we still know comparatively little about how the subject learns to make a verbal discrimination. Does the subject form an association between the correct and the incorrect item (i.e., some kind of mnemonic), or does he simply ignore the incorrect item and attend to the correct item? The frequency theory of verbal discrimination learning describes how a subject learns to make a verbal discrimination; it also raises some interesting questions concerning speech processes.

With regard to how a verbal discrimination is learned, frequency theory suggests that "the cue for discrimination is the subjective difference in frequency of occurrence between the C [correct] and I [incorrect] item in each VD pair" (Ekstrand, Wallace, & Underwood, 1966, p. 567). The "subjective" difference in frequency refers to the perceived difference between the correct and incorrect items. The subject gives greater attention to the correct item during VDL, according to the frequency theory.

Frequency theory suggests three distinct phases of VDL. First, the subject sees both items presented, and this initial perception leads to a representational response to each item. Second, the subject chooses one of the items as correct, and this choice constitutes a pronouncing response. Finally, the subject receives feedback on whether or not he made the correct choice. This feedback aids the subject's learning in that he is able to rehearse the correct response.

Frequency theory assumes that frequency "units" are built up by the individual during the three phases of VDL. For example, consider a subject learning to discriminate the correct words in a list of word-pairs. The anticipation method is employed, so the subject must guess which item is correct on the first trial. Initially, then, the subject sees the two items in the first pair (representational response). One frequency unit is emitted for each item (1:1). Next, the subject pronounces the item he thinks is correct (pronouncing response). Another frequency unit is added to the item chosen. Assuming that the correct item is chosen (which is not essential but simpler for this example), the frequency build-up becomes 2:1 in favor of the correct item. Finally, the subject sees the two items with the correct word underlined and presumably pronounces it to himself (rehearsal of the correct response), and another frequency unit is added to the correct item, which makes the frequency build-up 3:1 in favor of the correct item. Note that three frequency units are added to the correct item during the three phases of learning, while only one unit (representational response) is added to the incorrect item. According to frequency theory, the subject will learn to discriminate the correct item at criterion when the frequency build-up becomes sufficiently inordinate between the correct and the incorrect item. When the subject is responding at criterion, then, he is discriminating the correct item in each pair by picking the one he has seen (subjectively) more frequently.

According to frequency theory, the study-test method of list presentation should be superior to the anticipation method because the frequency units associated with pronouncing the incorrect item on the guessing trial would be eliminated (Ekstrand, Wallace, & Underwood, 1966, p. 568). That is, during the study trials, the subject would see both of the items in a pair and emit a representational response (1:1), and then he would see the correct item underlined (2:1). On the first test-trial, then, there already would be a frequency build-up in favor of the correct item. If, however, the anticipation method were used, the subject theorectically would miss 50% of the items by chance (incorrect pronouncing responses), thus detracting from the frequency build-up in favor of the correct item. Consequently, learning the list to a perfect performance criterion would be slower using the anticipation method.

While the pronouncing response directly involves speech, it has been stated that the rehearsal of the correct response "may be thought of as a pronouncing of the C item explicitly or implicitly" (Ekstrand, Wallace, & Underwood, 1966, p. 568). While speech occurs overtly during the pronouncing response, it apparently occurs covertly during rehearsal. "Verbalization," in this sense, is not bound to speech as an overt verbal act. Speech is merely an index of the subject's cognitive choice during the pronouncing response, and some process presumably related to speech occurs silently during the rehearsal of the correct response.

Several recent studies have examined the effects of spoken rehearsal on discrimination learning. Goulet and Hoyer (1969), Kausler and Sardello (1967), and Sardello and Kausler (1967) have found that saying both the correct and the incorrect items in a verbal discrimination pair leads to inferior learning as compared to silent rehearsal. Frequency theory can account for these findings in that pronouncing the incorrect, as well as the correct, item adds another frequency unit to the incorrect item, and thus diminishes the difference in frequency build-up in favor of the correct item. However, what if only the correct item is pronounced during the rehearsal of correct response? It would seem that frequency theory would predict no difference between saying the underlined item out loud and silently pronouncing it. If, however, there are unique effects associated with rehearsing the correct item out loud, then differences should be observed between spoken and silent rehearsal groups.

Support for the hypothesis that spoken rehearsal of the correct item aids learning has been found in a visual discrimination learning experiment. Carmean and Wier (1967), using a list of 10 familiar picture-pairs, found that rehearsing the correct item of the pair out loud was superior to a silent rehearsal by a control group. In addition, saying both items of the pair out loud was inferior to silent rehearsal.

Frequency theory, formulated to account for verbal discrimination, does not distinguish between explicit and implicit verbalization. Therefore, two experiments were conducted to determine whether or not spoken rehearsal of the correct item is superior to silent rehearsal. Further, since study-test and anticipation methods were employed in these experiments it was possible to determine the effect of eliminating pronouncing responses to the incorrect item. As was mentioned earlier, frequency theory predicts that the study-test is superior to the anticipation method of list presentation.

II

METHOD

Subjects

A total of 102 Communications Arts undergraduates participated in the two experiments for partial course credit. The first experiment (48 subjects) was conducted on the Milwaukee campus of the University of Wisconsin. The second experiment (54 subjects) was conducted on the Madison campus.

Lists

To add greater generality to the results, three lists of three- and four-letter low-frequency words from the Thorndike-Lorge (1944) tables were constructed. Each list contained 16 randomly paired words, and the selection of the correct word for each pair was also random. In the first experiment the lists were presented on a Lafayette memory drum, and the two words in a pair were presented one beside the other. To control for position learning, two random orders of each list were used with the correct word in a pair appearing once on the left and once on the right. In the second experiment, the lists were presented on a Stowe memory drum, and the two words in a pair were printed one above the other. Four random orders of each list were employed with the correct word in a pair appearing twice on the top and twice on the bottom. In both experiments, the number of correct words occurring in each position was not counterbalanced within any single list order.

Procedure

In both experiments, list learning was at a 2:2 second rate. A pair of words was presented for 2 seconds, and then the drum revolved and presented the pair again for 2 seconds (in the same position) with the correct word underlined.

In the first experiment, one- and two-study trials were administered. Subjects were informed that they were going to see a list of 16 word-pairs, one of which had been determined "correct" for purposes of the experiment. One half of the subjects were further informed that they would see the list once with the correct word underlined, and the other half were told that they would see the list twice. After the study trial(s), the subjects were instructed to pronounce the item they thought was correct during the first 2-second exposure (pronouncing response), and then the two items appeared again with the correct item underlined. The one- and two-study trials groups were further subdivided into spoken rehearsal and silent rehearsal groups. The spoken rehearsal group was instructed to say the underlined (correct) item out loud, while the silent rehearsal group was given no instructions to speak during the rehearsal of the correct response.

The second experiment (54 subjects) used the anticipation method, in which all subjects were informed of the task and told they would have to guess which item was correct on the first trial. Half of the subjects were given spoken rehearsal instructions, and the other half received silent rehearsal instructions. It should be noted that the guessing trial involved a pronouncing response (some correct and some incorrect), while the study-test method eliminated the pronouncing response. The variable distinguishing the spoken and the silent rehearsal groups was whether or not subjects said the underlined item out loud.

Subjects were assigned to one of the conditions within each of the two experiments by predetermined randomized blocks in order of appearance at the laboratory. Thus, subjects in Experiment I (study-test) were randomly assigned to one of the rehearsal conditions with one of the lists in one of the study-test methods. Subjects in Experiment II (anticipation) were randomly assigned to one of the rehearsal conditions with one of the lists. In both experiments, subjects were informed that they would be finished with the task when they could select the correct items in the list three times in succession.

Design

A 2 x 2 x 3 factorial design was used for Experiment I, with two levels of rehearsal (spoken and silent), two study methods (one- and two-study trials), and three lists. Since only the anticipation method was used in the second experiment, there were two factors on the design with the same two levels of rehearsal and the same three lists. In all, then, there were three study methods used in the two experiments. Experiment I employed one- and two-study trials, and Experiment II utilized one guessing trial. Consequently, the data from both experiments were into a 2 x 3 x 3 factorial with the two rehearsal methods, three lists, and three study methods, with study method being nested within experiment. For comparing the study-test methods to the anticipation method, Trials 1 through 9 of the study test were combined with Trials 2 through 10 (omitting the guessing trial) of the anticipation method. Consequently, Trial "1" in the analysis of data refers to performance after one or two study trials (Experiment I), or one guessing trial (Experiment II).

The dependent measures were trials to criterion and number of mistakes. While trials to criterion were analyzed in the univariate design described above, mistakes were analyzed in a multivariate design, with the nine test trials included as a within subjects factor.

IV

RESULTS

By way of overview, the univariate analysis of variance produced only a significant rehearsal main effect. The list and study method main effects did not approach the criterion for statistical significance, nor did any of the interactions. The multivariate analysis of variance for mistakes yielded significant main effects for rehearsal and trials, and a significant Study Method X Trial interaction. None of the other main effects or interactions was significant.

For spoken rehearsal subjects, the mean number of trials to reach the criterion of three successive perfect trials (including the criterion trials) was 7.14, while the silent rehearsal subjects averaged 8.57. This difference was significan at $\underline{p} < .01$ ($\underline{F} = 7.61$; $\underline{df} = 1,84$).

The mistakes measure yielded similar results between groups. Spoken rehearsal subjects averaged 2.42 mistakes per trial, while the silent rehearsal group averaged 4.14 mistakes. This difference was also significant ($\underline{F} = 10.33$; $\underline{df} = 1,84$; $\underline{p} < .005$). The comparisons among means of the study test _versus_ anticipation trial methods approached significance ($\underline{F} = 2.60$; $\underline{df} = 2,84$; $\underline{p} < .10$), but it would appear that this was a function of minimal errors per trial for the two study trials group

($M = 2.19$) as compared to the one study trial and one guessing trial groups ($M = 3.76$ and 3.56, respectively).

The effect of mistakes over trials was highly significant ($F = 47.74$; $df = 8,77$; $p < .0001$), as all subjects improved over trials. Surprisingly, there was no significan Rehearsal x Trials interaction ($F = 1.67$; $df = 8,77$; $p < .12$), which suggests that the spoken rehearsal group was superior to the silent rehearsal group throughout the nine test trials. However, this effect is at least partially due to the method of scoring. Once a subject reached criterion (three perfect trials in succession), a perfect score was assigned to that subject for the remainder of the nine trials. Since spoken rehearsal subjects reached criterion in fewer trials, there were more "perfect performance" scores given to these subjects. Thus the scoring method, as well as the effect of spoken rehearsal, contributed to the lower error rate of the spoken rehearsal group.

There was a also significant Study Method x Trials interaction ($F = 3.65$; $df = 16.154$; $p < .0001$). Inspection of the trend data revealed significant linear and quadratic components. On the first trial, the two study trials method produced comparatively few errors ($M = 1.62$), while the one study trial and the one guessing trial methods produced 3.96 and 4.27 mean mistakes, respectively. As the quadratic component suggests, however, these differences diminished over trials.

A Scheffé multiple comparisons test on first-trial mistakes indicated no significant difference between the one study group and one guessing trial group ($F < 1$). However, the two-study trial group made significantly fewer errors than both of the former groups ($F = 13.95$;

df = 1,84; p < .001). Mean mistakes on the first test trial for the Study Methods X Rehearsal group is shown in Table 1. While the means for study method within spoken rehearsal are in the direction predicted by the frequency theory, silent rehearsal produced about the same number of errors in the one study and one guessing trial conditions. A Scheffe multiple comparisons test indicated that this interaction did not reach the criterion for statistical significance ($F = 2.04$; $df = 1,84$; $p < .15$).

Table 1

Mean Mistakes on the First Test Trial for Spoken and Silent Rehearsal in the Three Study Method Conditions

Rehearsal \ Study Method	One Guessing Trial	One Study Trial	Two Study Trials	Mean
Spoken	3.92 n = 27	2.92 n = 12	1.42 n = 12	3.10 n = 51
Silent	4.62 n = 27	5.00 n = 12	1.83 n = 12	4.05 n = 51
Mean	4.27 n = 54	3.96 n = 24	1.62 n = 24	

IV

DISCUSSION

In general, these results are consistent with the visual discrimination results reported by Carmean and Wier (1967). Spoken rehearsal was superior to silent rehearsal as indexed by the trials to criterion and mistakes measures. However, there is no significant difference between mean mistakes on the first trial for the one study group and one guessing trial group, which does not confirm the frequency theory prediction. This finding suggests that the 2:1 build-up from the one study trial did not establish the necessary frequency cue for making successful verbal discriminations. It would seem that, since there were no differences between these two groups, the one guess trial group overcame the handicap expected to result from making incorrect pronouncing responses during the guessing trial. In this context, then, the rehearsal of the correct response should be more heavily weighted than the pronouncing response.

Another explanation of this lack of difference between the effects of one study and one guessing trial can be deduced from examination of the interaction between rehearsal mode and study method. As can be seen in Table 1, the observed means for spoken rehearsal are in the predicted direction, while silent rehearsal produced slightly more mistakes in the one study trial group. However discussion of this interaction must be prefaced by acknowledging that it did not reach the criterion for statistical significance, and that the comparison between one study and one guessing trial is confounded with the two separate experiments. Concerning the lack of statistical significance ($F = 2.04$; $df = 1,84$; $p < .15$), this finding could be a function of "floor" effects. That is, there were comparatively few errors on the first test trial in all conditions. Concerning the confounding there is little reason to suspect experimenter or subject differences. Another experiment, using longer lists and a complete factorial design, is in progress.

Assuming the "significance" of this interaction between rehearsal mode and study method, the two additional interpretations of the frequency theory are possible, The first follows the "production deficiency" reasoning by Flavell and his associates (Flavell, Beach, & Chinsky, 1966; Keeney, Cannizzo, and Flavell, 1967) to explain "mediational deficiencies" in young children. The production deficiency hypothesis suggests that young children tend not to silently produce verbal mediators which aid in task performance (like repeating items silently during rehearsal in a memory task), but instructions to say the words out loud provide a "cognitive trick" to aid recall.

The frequency theory assumes that the cue for making successful verbal discriminations is established by the inordinate build-up of subjective frequency units in favor of the correct item. These frequency units are emitted when seeing the correct item in the pair (1:1), choosing it (2:1), and rehearsing it (3:1). Perhaps, however, silent rehearsers do not emit a frequency unit during the rehearsal when they passively observe the correct response (e.g., perhaps they give some attention to the incorrect item), and instructions to say the correct item out loud insures the rehearsal of the correct response.

The above reasoning suggests that silent rehearsers are doing something other than simply pronouncing the correct items silently to themselves. A second line of explanation suggests that there are unique effects associated with pronouncing items out loud. While silent rehearsers are indeed pronouncing the correct item implicitly, explicit pronounciation affords distinct advantages such as acoustic feedback, articulatory feedback, or dual modality information processing.

If the speech response does somehow add frequency cues during VDL, the present experiment is somewhat confounded, in that both silent and overt rehearsers spoke during their choice of the correct item (pronouncing response). Experiments are currently being conducted in which silent pronouncing response groups (button-press) are being compared to spoken pronouncing response groups. Still other avenues to produce the "cognitive trick" are being pursued. Instructions specifically requesting silent rehearsers to pronounce the correct item silently to themselves are being designed. Also, having only the correct item appear during the feedback frame provides greater control over silent rehearsal strategy.

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