

A method for observing rehearsal and natural language mediation in short-term memory¹

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In a short-term memory (STM) study a modified "think aloud" method, using automated operant conditioning with points as reinforcers, effectively suppressed covert rehearsal but permitted overt rehearsal. Recall efficiency under modified think aloud conditions, with rehearsal and natural language mediators observable, did not differ significantly from recall efficiency under the silent condition. The new method may make possible observation of verbal mediation in STM and other verbal learning experiments.

Peterson & Peterson (1959), having Ss count backward during the retention interval, prevented covert rehearsal in a STM experiment and demonstrated that rehearsal is essential for efficient recall. Subsequent studies by Murdock (1962) and Loess & McBundy (1965) have shown similar results, that counting backward by 3s or 4s interferes with the recall of verbal material. Thus the Peterson and Peterson method has made possible a series of significant findings in short-term memory, but the method does not permit observations of the frequency or strategies of rehearsal or natural language mediators. Consequently, in STM studies, rehearsal and natural language mediation must be prevented or inferred rather than observed.

If it is assumed that verbal mediation and covert rehearsal are implicit speech (Watson, 1913) which differ from overt speech chiefly in amplitude (Skinner, 1957), then the think aloud method offers promise in the study of mediation in STM. The think aloud method succeeds in making many covert mediators overt, but the method has a crucial weakness. It permits short silent periods when Ss can make and edit covert verbal responses before producing overt responses (Clarapede, 1934; Duncker, 1945; Vinacke, 1952).

Weiner (1962) has shown that by using operant conditioning methods, with points on a counter as reinforcers, precise control over human keypressing behavior can be obtained. By applying Weiner's methods to verbal behavior, Blackwood (1965) modified the think aloud method. With the new method, overt verbal behavior was maintained at high rates while covert mediating responses were apparently suppressed. When a thinking task such as problem solving was reinforced, Ss thought aloud at the required high stable rate. Thus, mediating problem solving responses were made consistently observable.

The present methodological study was designed to

determine if covert rehearsal in STM could be made overt by means of the modified think aloud method. Specifically, the experiment tested the hypotheses that (1) being forced to talk continuously, with rehearsal permitted, does not interfere with short-term recall, and (2) being forced to talk continually, with rehearsal prevented, effectively prevents short-term recall.

Method

The Ss were six volunteers from the undergraduate educational psychology classes taught by one of the Es. All Ss were female.

Materials consisted of six tape-recorded lists of syllables, each containing 48 CCC trigrams from Witmer (1935). Syllables were randomly selected and assigned to six lists so that the mean association value for each list was 21%.

Apparatus consisted of a two-channel tape recorder for presenting syllables and cues, and behavioral programming equipment arranged to produce scheduled light cues, sound cues, and point losses. High verbal response rates were maintained in the following manner. S was on what might be called a "differential punishment of low rate" schedule; that is, whenever S paused for a period greater than 0.30 sec, or failed to produce seven voice pulses in a 5 sec period, S received rapid point losses at the rate of eight per sec. The point losses were indicated on a counter mounted in front of S and also by a flashing red light and bursts of white noise. The resumption of rapid speech terminated point losses and the associated cues. In other words, the differential punishment of low rates schedule made point losses on the S's counter contingent upon slow rates of vocalization and, in this way, high, stable rates of speech were maintained.

The S was seated in a sound insulated booth separated from the E and wore a throat microphone which was connected to the voice-operated relay, which in turn controlled the equipment which programmed the S's point losses. S also wore earphones into which were played the recorded syllables and cues to recite. A second tape recorder, connected to a microphone on S's desk, recorded all vocal responses.

The STM procedure was as follows (1) presentation of the syllables, (2) 20 sec retention interval, (3) tone, (4) recitation. Fifteen sec after the tone, the

next syllable was presented, and the procedure was repeated. All Ss were run under three conditions: silent rehearsal, alternate rehearsal, and counting backwards. In more detail, the three conditions were:

Silent rehearsal. The differential punishment for low rate schedule was not in effect; thus, the S was not forced to talk during the retention interval. It was assumed that under this silent rehearsal condition the trigram would be covertly rehearsed.

Alternate rehearsal. The S was "forced" to talk at high stable rates by scheduling point losses contingent upon slow rates. The S was required to recite random numbers and rehearsal was permitted between random numbers with the condition that at least one random number must be emitted between each two trigram responses. The result was a high rate of vocalization similar to the following: "ZBX, 36, ZBX, 72, ZBX, 21, 58, ZBX,..." etc. It was assumed that generating random numbers would prevent covert rehearsal between overt CCC responses.

Counting backward. The S was instructed to count backward continuously by 3s. A three digit number was presented immediately after each trigram, and S started with this number. The differential punishment for low rates schedule maintained high, stable rates of counting backward.

White, green, and yellow lights indicated which condition was in operation. A block of four syllables was presented in any condition before shifting to the next condition. Each S went through the three conditions repeatedly in the same order for a total of four presentations of each condition, but the order of conditions was completely counterbalanced between Ss.

In order to insure high stable rates of verbal behavior, each S was trained under the modified think aloud method for about 20 min. At the end of the training session all Ss emitted verbal responses at high stable rates with few pauses. On the following day each S was given a practice tape, essentially similar to the six experimental tapes except that different trigrams were used. S was taught to use the desired response mode under each of the three conditions as indicated by the cue lights. On the third day, all Ss responded to one of the six experimental tapes, and data were collected.

Results and Discussion

The number of correct responses was tabulated for each block of trials, producing a single score for each block of four trials. From 16 syllables presented to each S under each condition, the mean number of syllables recalled correctly was, for the Silent Rehearsal condition, 14.17 (SD=1.65); the mean

number of syllables recalled correctly for the Counting Backward condition was 2.00 (SD=1.41); and for the Alternate Rehearsal condition, the mean number of syllables correctly recalled was 12.17 (SD=1.84). A t test of the difference between the means of the Silent Rehearsal and Alternate Rehearsal conditions yielded a value of $t=1.81$ (10 df) which was not significant. A test between means of the Silent Rehearsal and the Counting Backwards conditions yielded a value of $t=12.68$ (10 df), which was significant beyond the .01 level. For the difference between the means of the Alternate Rehearsal condition and the Counting Backward condition, a t test yielded a value of $t=9.87$ (10 df), which was significant beyond the .001 level.

Results support the hypothesis that the modified think aloud method prevents recall. Since the mean correct responses out of 16 trials on the Counting Backward condition was only 2.00, it can be inferred that forced counting backwards does interfere with effective rehearsal. The predicted results were obtained in the comparison between silent rehearsal and rehearsing aloud. However, this "no difference" finding must be interpreted with caution.

The findings suggest that the modified think aloud method leads Ss to shift from covert to overt verbal responses without significantly changing content. The method appears promising for the study of rehearsal and natural language mediation in STM, paired associate learning, serial learning, skill learning, etc.

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Note

1. This research was supported in part by USPHS Grant MH 11017-01.