Rehearsal For Naming In Apraxia Of Speech

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Introduction

The purpose of this study was to investigate the effects of rehearsal on the phonemic accuracy of speech in patients with verbal apraxia. Many apraxic patients who successfully imitate articulations have difficulty recalling articulations. When normal adults attempt to remember verbal stimuli (e.g., a phone number or someone's name) they use an internal articulatory process known as rehearsal. During rehearsal, stimuli are recoded into acoustic or articulatory images for processing and storage (Conrad, 1964; Wicklegren, 1966; and Hintzman, 1967), and are eventually transferred from short-term memory to long-term memory (Waugh and Norman 1965). McGuigan (1970) demonstrated that rehearsal is usually accompanied by small, covert movements of the lips, tongue and larynx, in other words implicit speech. Rosenbek (1976) contends that apraxic patients may have relatively intact implicit speech, and Nebes (1975) confirmed the presence of normal implicit speech patterns in a patient with severe verbal apraxia. While studying the effect of response delay on phonemic accuracy in apraxia of speech, Deal and Darley (1972) observed that some patients made silent productions during delay intervals. However, there is no evidence which suggests that apraxic patients can use rehearsal to increase their retention of articulatory patterns.

In this study, the variable of interest was the phonemic accuracy of recalled nouns studied under two conditions, one wherein the words were studied in an imitation mode, the other, a rehearsal mode, wherein words were studied using controlled retention intervals. It was hypothesized that phonemic accuracy during recall would be greater for words studied in the rehearsal condition than for words studied in the imitation condition. Further, it was hypothesized that phonemic accuracy in the two study conditions would be related to the S's tested capacity for implicit speech.

Method

Subjects

Five S's, four male and one female, served as their own controls, (Table 1). They ranged in age from 45 to 70 years, varied in length post onset from 10 to 67 months, and had predominantly left unilateral lesions caused by either thrombosis or embolus, resulting in aprasia of speech and concomitant nonfluent Broca's aphasia. As an index of severity, the S's overall percentile ranks from the Porch Index of Communicability (Porch, 1967) are shown. All S's demonstrated reasonably proficient imitation skills.

Using a technique described by Nebes (1975) each S's capacity for implicit speech was determined. Following explanation of the task and several examples, the S was presented a list of words (Table 2) and was asked to silently read each word and write down the number of syllables it contained.

Table 1. Subjects

Subjects	Age	MPO	Etiology	PICA
1	45	16	L CVA	70
2	70	65	L CVA	68
3	54	10	L CVA	73
4	59	67	L CVA	70
5	56	26	L CVA	59

Table 2. Stimuli For Syllable Identification

Bike	Pen
Sandwich	Skeleton
Ladder	Match
Telephone	Farmer
Shovel	Plan
Car	Government
Toothbrush	Block
Motor	Ambulance
Screwdriver	Pain
Candle	Officer

Stimuli

The experimental stimuli consisted of 50 two-syllable nouns, 10 for each of the 5 S's Each noun was chosen on the basis that (1) the S was able to correctly repeat the word, but unable to correctly name a picture of the word, and (2) the noun was similar to the other nouns selected in length and certain phonemic characteristics.

Table 3. Ten Stimuli Selected For S 2

Dustpan
Birdbath
Toothbrush
Golfclub
Briefcase
Stapler
Lightbulb
Sandwich
Pheasant
Scissors

As an example, the ten words selected for S 2 are presented in Table 3. For each S, the ten stimuli were randomly assigned to the two study conditions, five to an imitation condition and five to a rehearsal condition. Using the Mann-Whitney-Wilcoxon procedure (Gibbons, 1976) it was determined that, for each S, words in the two study conditions did not differ ($p>.05$) in either the number of phonemes per word or in the number of typically difficult consonants or consonant clusters, such as those identified by Johns and Darley (1970).

Procedures

As a baseline measure, each S was presented with 2 x 2 photographs of the ten stimuli and asked to identify each one by name. Responses were recorded on audio tape and phonetically transcribed. The S was then instructed that he was going to study some words, and that he should try to remember them. In the imitation condition, the S was further instructed to carefully repeat and remember the words. In the rehearsal condition the S was further instructed that he would only hear the word once, and he should remember it by saying it to himself silently, over and over again. With the stimulus picture visible to the S, each study condition was initiated by the E saying the stimulus word and the S repeating it. In the imitation condition the E followed the S's repetition by saying the name again, the S repeated, E said the name, S repeated, and so on for 60 seconds. For each word a maximum of 20 repetitions, or one every three seconds was allowed. In the rehearsal condition the S's initial repetition was followed by a retention interval of 5 seconds, at which time E used a gesture to request that the S say the word. This request was made again at time points of 15, 30 and 60 seconds, a total of tive times during the 60 second period. The labels imitation and rehearsal were not used to imply that rehearsal may take place in one condition and not in the other. The distinction between the two is that, to study words in the imitation condition, retention of the word was not necessary. Retention of the word was necessary to study words in the rehearsal condition: The S was instructed to rehearse the word, and was given an opportunity to do so during retention intervals of increasing length.

Once the study of all five words in a condition was completed, the S was asked to name each of the five pictures; these were presented one at a time, in the same order as they were studied. This measure will be referred to as "immediate recall".

The ten words were studied for five sessions, one session per day for five consecutive days. The order of the two study conditions was counterbalanced across sessions. Three, five and seven days after the fifth study session each S was asked to name all ten of thepictured stimuli. For each S, words from the two study conditions were combined in random order. This measure will be referred to as "extended recall". All responses during immediate and extended recall were tape recorded and later phonetically transcribed. Two independent transcriptions of selected sections achieved a .90 coefficient agreement.

Analysis of Results

For each S the data were analyzed in two ways. First, differences between the two study conditions in the number of correct phonemes at baseline, during immediate recall and during extended recall were tested. This was

accomplished with the Mann-Whitney-Wilcoxon procedure. Actual differences at baseline in the number of correct phonemes between the two study conditions necessitated the use of difference scores to compare performance during immediate and extended recall. Second, for each S, differences in the number of correct phonemes between baseline, the last immediate recall measure and the last extended recall measure within each study condition were tested. For this purpose, a Kruskal-Wallace one-way analysis of variance and a Sheffe' post-hoc procedure were used.

Results

Figure 1 shows, for S 1, the percent change in correct phonemes as a function of immediate recall measures and for three extended recall measures at A (3 days) B (5 days) and C (7 days) after the final study session. The data are shown separately for the imitation condition (the solid line) and for the rehearsal condition (the broken line).

Percent change in correct phonemes was used for the same reason that difference scores were used in the statistical analyses. That is, differences at baseline in the number of correct phonemes between the two study conditions would confound later comparisions of actual increases in correct phonemes for the two conditions, if these increases were represented only by total percent correct. For example, at baseline, S 1 recalled 43.4% of the phonemes in the imitation conditions correctly, but recalled 50% of the phonemes in rehearsal conditions correctly. At recall measure one, the total percent correct for each study condition was 78.7%; however, actual increases in phonemic accuracy as they are represented here (Figure 1) were 35.3% in the imitation condition and 28.7% in the rehearsal condition.

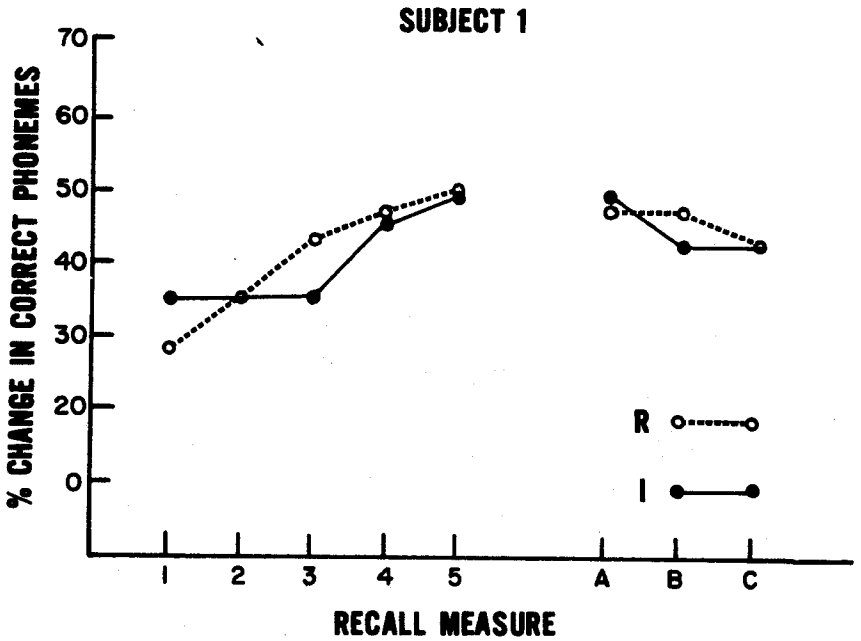

Figure 1. Percent change in correct phonemes during immediate and extended recall as a function of imitation and rehearsal conditions for S1.

For S 1 the differences in percent correct phonemes between the study conditions at baseline was not significant at the .05 level; at the fifth immediate recall measure, both study conditions had produced increases in phonemic accuracy of about 50%; these increases were significantly different from baseline ($p<,05$), but not significantly different from each other. During immediate recall, the rehearsal condition elicited a slightly greater increase in correct phonemes than did the imitation condition, but the difference was not significant. During extended recall, S 1 maintained a significant increase in correct phonemes as compared to baseline, but at one week following the last study session (C) increases in phonemic accuracy between the two conditions were identical.

For S 2 (Figure 2) at baseline, percent correct phonemes in imitation was 61.3% and for rehearsal 60%. At the fifth immediate recall measure, both study conditions had produced increases in correct phonemes of about 30% which were not statistically different from baseline accuracy, and not significantly different from each other ($p>.05$). During immediate recall, the rehearsal condition elicited a greater increase in correct phonemes than did the imitation condition; this difference approached, but did not reach significance ($p>.05$). Increases in correct phonemes were maintained during extended recall, and following a retention interval of one week, the effects of the two study conditions as for S 1, were almost identical.

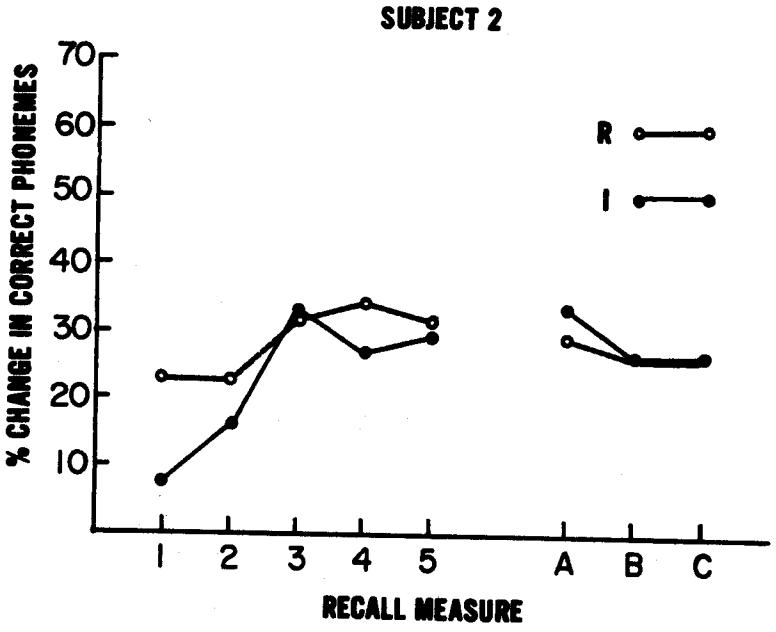

Figure 2. Percent change in correct phonemes during immediate and extended recall as a function of imitation and rehearsal conditions for S2.

For S 3, (Figure 3) at baseline, percent correct for imitation was 56 and for rehearsal, 51.5. By the fifth recall measure, imitation had produced a 28.1% increase in phonemic accuracy; this was not statistically different from baseline. Rehearsal elicited a 45.5% increase; this was statistically different from baseline at the .05 level of confidence, and these increases were signifi-

cantly different from each other ($p<.05$). At the first extended recall measure, (A) three days after the fifth study session, the advantage in the rehearsal condition was still present. However, by the seventh day of retention, percent increase in phonemic accuracy of recalled words was almost equal for the two study conditions, just as they were for S 1 and for S 2.

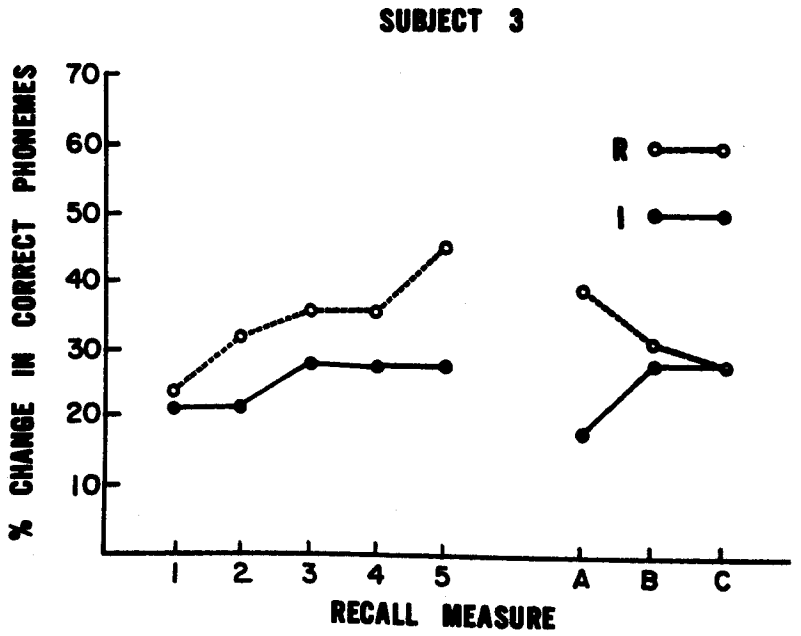

Figure 3. Percent change in correct phonemes during immediate and extended recall as a function of imitation and rehearsal conditions for S3.

For S 4 (Figure 4) at baseline, percent correct phonemes for imitation was 34.4, and for the rehearsal condition, 41.4. At the fifth immediate recall measure, imitation had produced a 62.2% increase in phonemic accuracy, which was significantly different from baseline accuracy ($p<.01$). The rehearsal condition produced a 41.2% increase in phoneme accuracy; this increase was not significant. During immediate recall, the imitation condition produced a greater increase in phonemic accuracy than did the rehearsal condition, a significant difference ($p<.01$). At seven days after the last study session the superiority of words studied in the imitation condition was still present.

For S 5 (Figure 5) at baseline, percent correct phonemes for imitation was 40.2 and for rehearsal, 50.1. At the fifth recall measure, the imitation condition had elicited a 54.8% increase in phonemic accuracy, which was significantly different from baseline. The rehearsal condition produced a 40% increase in phonemic accuracy which was not significant. The percent change in the correct phonemes produced by the two study conditions were not statistically different. The irregularities in this S's data are due to several neologisms, produced at recall measure three in rehearsal, and at the fourth recall measure in imitation. In imitation percent change of correct phonemes deteriorated during extended recall, the difference between the two conditions diminishing to 1.6%.

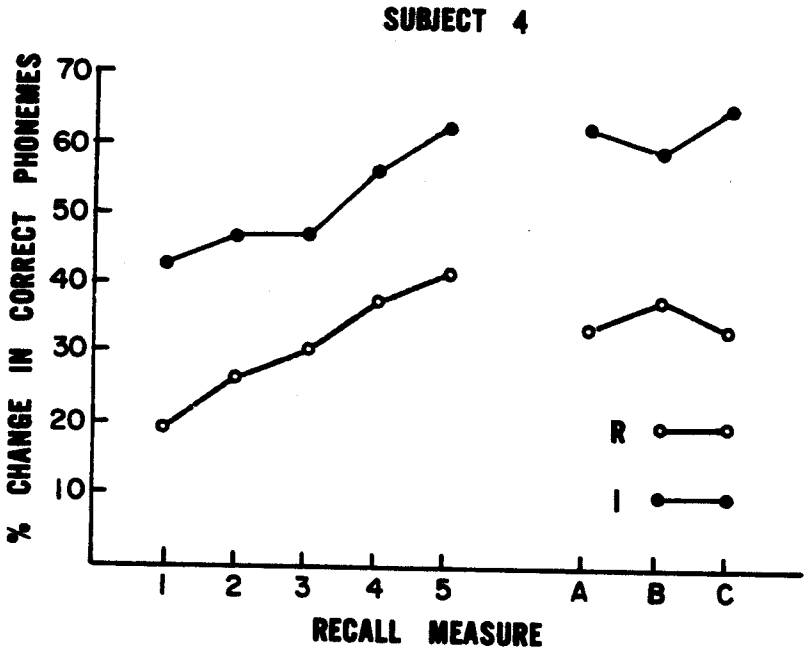

Figure 4. Percent change in correct phonemes during immediate and extended recall as a function of imitation and rehearsal conditions for S4.

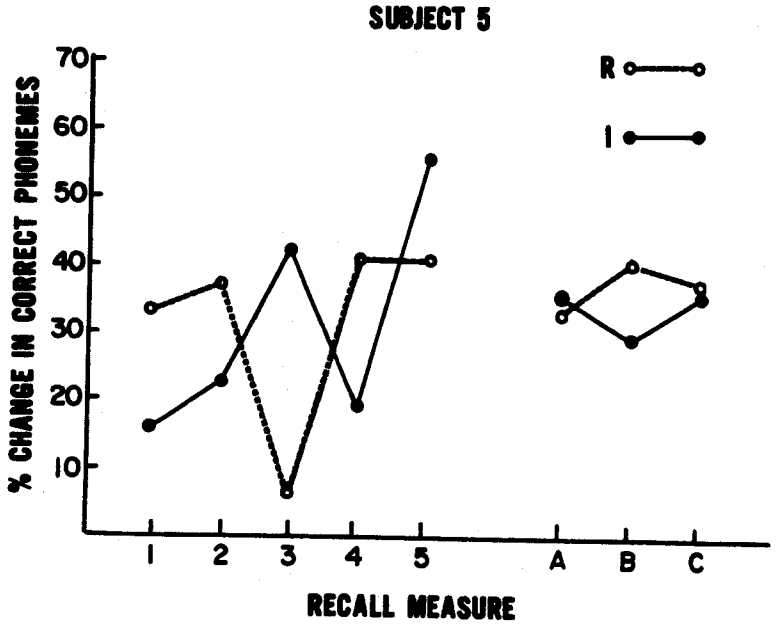

Figure 5. Percent change in correct phonemes during immediate and extended recall as a function of imitation and rehearsal conditions for S5.

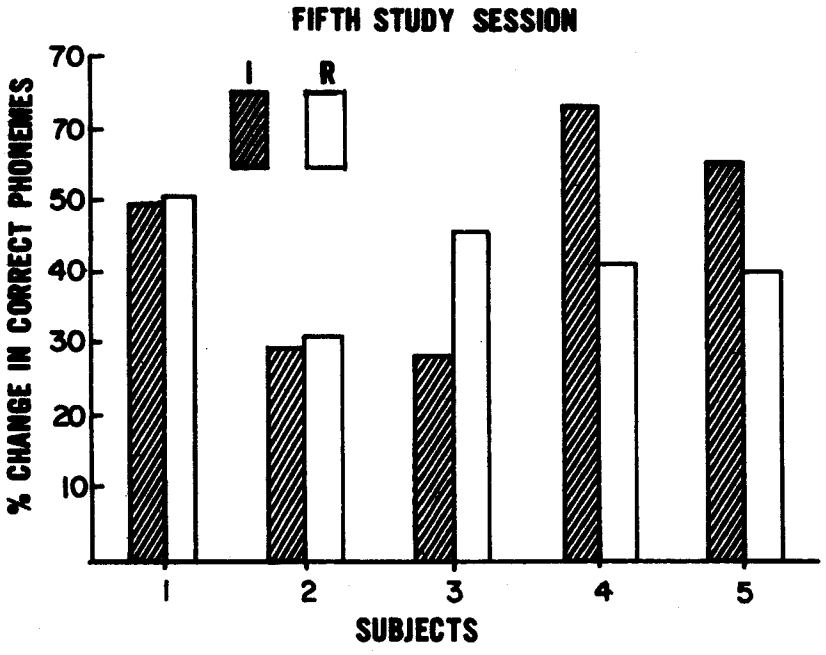

Figure 6. Percent change in phonemic accuracy from baseline to immediate recall at the fifth study session for each S, in imitation and recall condition.

Figure 6 summarizes the percent change in phonemic accuracy from baseline to immediate recall at the fifth study session for each of the 5 S's for imitation and for rehearsal conditions. These data illustrate several points. Overall gains in phonemic accuracy differed across S's. In addition, by the fifth immediate recall measure, two S's (1 and 2) increased their phonemic accuracy to approximately the same degree in both study conditions, while S 3 showed a distinct rehearsal condition advantage, and S's 4 and 5 recalled phonemes more accurately in the imitation condition.

One week later (Figure 7) only one of the five S's showed a significant study condition effect. S 4 continued to recall phonemes studied in the imitation condition with greater accuracy that those words studied in the rehearsal condition. Study condition effects were nearly identical for S's 1,2, and 3; S 5 showed slightly better performance in the rehearsal condition.

These data do not support the hypothesis that apraxic patients recall phonemes of words studied in a rehearsal mode more accurately than they recall phonemes of words studied in imitation. In fact, after a retention interval of one week, the percent increases in phonemic accuracy between the two study conditions were almost identical for four of five S's. However, this was achieved, in theimitation mode, with a ratio of up to 20 presentations of the stimulus for each minute that the word was studied, while in rehearsal, this was achieved with only one presentation of the stimulus for each minute that the word was studied. From this standpoint, the rehearsal study mode may be considered more efficient thatn the imitation study mode.

The only S who demonstrated a study condition effect performed more accurately in imitation then he did in rehearsal. This result becomes interesting upon examination of the five S's performance on the syllable identification test (Table 4). Those S's with relatively high scores, or those with a greater tested

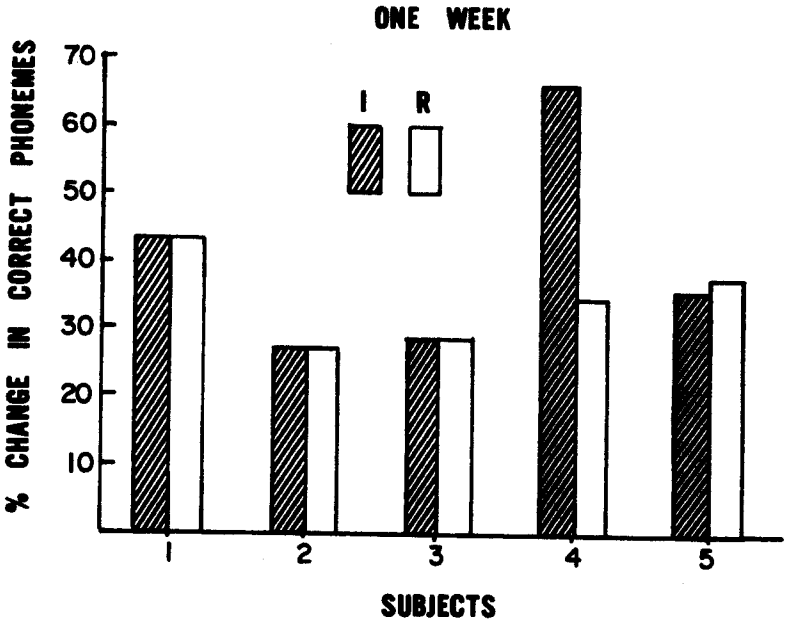

Figure 7. Percent change in phonemic accuracy, one week after the fifth study session for each S in imitation and rehearsal condition.

capacity for implicit speech (S's 1, 2, 3, and 5) recalled phonemes with equal accuracy in the two study conditions. S 4's score on the syllable identification test was relatively low (40%), and this S demonstrated a significant preference for studying in the imitation mode.

Table 4. Percent correct responses on the syllable identification task for each S.

Subject	Score
1	100%
2	75%
3	90%
4	40%
5	75%

S 4's inability to use rehearsal as effectively as imitation lends itself to several interpretations. One is that he did not rehearse. The other is that he did rehearse, but his comparatively reduced capacity for implicit speech resulted in the retrieval of inaccurately rehearsed phonemes. Covert rehearsal cannot be observed, so it is possible that S 4 did not rehearse.

However, similar to S's 1, 2, 3 and 5, S 4 seemed to be actively engaged in silent rehearsal of the stimuli during the study intervals. Considering S 4's relatively poor performance on the syllable identification task, his preference for imitation may be associated with a reduced capacity to use implicit speech for rehearsal.

Treatment strategies for apraxia of speech, such as Rosenbek et al. (1973) incorporate response delays or retention intervals into their paradigms. However, the usefulness of such delays may depend (as suggested by Deal and Darley, 1972) on how thepatient uses such an interval. In the present study, 4 of 5 S's demonstrated some capacity for implicit speech, were given instructions to rehearse, and given an opportunity to rehearse; yet they demonstrated no rehearsal advantage in long-term retention of phonemes. This result questions the usefulness of response delays as a separate procedure in paradigms for apraxia of speech.

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Discussion

Q. Was the order of presentation of the two study conditions randomized?
A. Yes, it was. The order was randomized across study conditions but was kept constant for each subject.

Q. Was there some carry-over of instructions in one study condition to the other?
A. Prior to each study condition, instructions for that condition were presented to each subject. All subjects were able to participate in the study condition as instructed.

Q. Did you gather data as a function of the increasing interval that you provided for rehearsal, the 5-15-30 in terms of accuracy? It seemed like a good opportunity to get some data, make some inferences on the nature of memory function.
A. Yes. There are a lot of data which was not presented here. For instance, accuracy of production during imitation vs. rehearsal did differ among subjects. Overall accuracy in each of the two study conditions during study was about 88-89%. Just recalling things from memory, I would say that there was no marked difference in the accuracy of phonemes over the retention intervals that were chosen for the study; that is why they were limited to 60 seconds. I think that if you extended the retention intervals you would eventually find differences.

Q. Did you vary the intervals in both conditions in the same way? 5 sec-15-20?
A. For all subjects, the retention intervals were the same.