Word Recall in Aphasia*

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ABSTRACT

Aphasic and normal subjects listened to lists of ten words in a probe recall paradigm. Memory function was assessed by estimating the probabilities of recalling a word from either long-term store or short-term store. When compared to the normal subjects, nine of the ten aphasic subjects showed deficient ability to recall a word from short-term store, and no capability to recall from long-term store. The memory functions of the remaining aphasic subject were anomalous: he showed no ability to recall words from short-term store, but an increased ability to recall from long-term store.

INTRODUCTION

Two common symptoms observed in patients diagnosed as aphasic are a greatly reduced vocabulary and difficulty in recalling strings of digits or words. To a psychologist these symptoms might indicate abnormal memory processes. Models of memory usually consist of the two components, long-term store (LTS) and short-term store (STS), where LTS is the permanent information store and STS retains briefly a small number of items (Waugh and Norman, 1965; Atkinson and Shiffrin, 1968). Accordingly, reduced vocabulary could be viewed as a problem in accessing and retrieving words from LTS, and shortened auditory retention span might reflect deficient STS function.

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Only a few experiments have been conducted to assess memory function in aphasic patients. This is not surprising since aphasia is defined as a language disorder, and although normal language communication must depend on normal memory function, the relationship between the two has rarely been discussed (cf. Norman, 1972; Aaronson, 1974). Nonetheless, in a study of patients with different neurologically based language disorders, Halpern, Darley, and Brown (1973) found that out of ten language functions, aphasics performed poorest on Adequacy (word-finding difficulties) and Auditory Retention Span.

Several studies have compared visual versus auditory STS functions with some aphasic patients. Luria, Sokolov, and Klimkowski (1967) studied two aphasics whose main symptom was the inability to repeat a series of auditorily presented words (acoustic-mnestic aphasia). They showed that difficulty in recalling a series of three to five words was specific to the auditory modality. They did not discuss a two-component memory model. Butters, Samuels, Goodglass, and Brody (1970) tested groups of brain-damaged patients, some of whom were aphasic, on recall of consonants presented visually or auditorily. A Peterson and Peterson (1959) paradigm was employed to test immediate and delayed recall for either single consonants or consonant trigrams. Patients with left-hemisphere, parietal brain damage (all eight were aphasic) had memory deficits in both visual and auditory tasks. Patients with left-hemisphere, frontal brain damage (seven aphasic, one nonaphasic) were thought to have no memory deficits, but rather an impairment in registration of the consonants. They concluded that "apparently, aphasic and memory disorders represent separate and independent processes" (p. 457). It is not clear that their own results fully support this generalization. In addition, they have not taken into account the fact that in normal subjects visually presented consonants are often encoded in a phonological form in immediate memory (Conrad, 1964; Wickelgren, 1965; Conrad, 1972), an effect which may have confounded their results (cf. Warrington and Shallice, 1972).

Two other studies have compared memory processes between aphasic and normal subjects. In one of those (Carson, Carson, and Tikofsky, 1968) only quantitative differences were found between aphasic and normal subjects in several learning tasks including a verbal serial learning task. In the other study (Swinney and Taylor, 1971) both quantitative and qualitative differences were observed in a nonverbal task examining the search process in STS.

A series of memory experiments for both STS and LTS have been conducted by Warrington and her colleagues using primarily one patient (KF) thought to have conduction aphasia, and whose main symptom was the inability to repeat a series of words (Warrington and Shallice, 1969; Warrington, Logue, and Pratt, 1971; Warrington and Shallice, 1972; Warrington and Weiskrantz, 1973). The main outcome of the research on KF is his selective impairment of auditory versus visual STS, and selective impairment of LTS versus STS. In another study of one conduction aphasic, Strub and Gardner (1974) accounted for the repetition difficulties primarily as a result of a linguistic-phonological deficit rather than a memory dysfunction.

The present study compared both long-term and short-term memory functions for groups of normal and aphasic subjects. We chose a probe-recall paradigm based on the work of Waugh and Norman (1965) in which separate functions for LTS and STS are derived from one set of data. The procedure was to present tape-recorded word lists, with each list followed by a tone and a word drawn from the
list—the "probe word." The probe word occurred in various positions on the lists and the subject's task was to recall the word following the probe word. Previous experiments have reported right-ear superiority in recalling words presented monaurally (Bakker, 1969; Turvey, Pisoni, and Croog, 1972). Thus, the word lists were presented monaurally to test for possible ear differences in this experiment.

**METHOD**

**Word Lists**

In principle, the word lists were constructed to test the memory of an aphasic subject, not his difficulties in word usage. It has been reported that the variables of frequency of occurrence, part of speech, and abstractness (among others) do affect aphasic patients' use of words (cf. Halpern, 1972). With this in mind, the words chosen for this experiment were selected from the Thorndike and Lorge (1944) count of the 1000 most frequent words in English, excluding proper nouns and function words of three letters or less. Since high frequency words are easiest for aphasics to use (Schuell, Jenkins, and Landis, 1961) and many of the other variables correlate with word frequency, the words selected should present minimal difficulty for the subjects. Proper nouns and short function words were excluded for several reasons, one of which was that they tended to stand out in the word lists.

Thirty word lists of ten words each were constructed, words were selected in a quasi-random way, and only a few words were repeated across lists. Probe words were chosen so that positions 2, 4, and 6 were probed twice for each ear and positions 7, 8, and 9 were probed three times for each ear, following the procedures of Kintsch and Buschke (1969) and Turvey et al. (1972). Word lists were presented 15 times each to the left and right ears, with ear presentation alternated randomly.

The lists were read by the experimenter in a quiet room (IAC 1201) and recorded on a Uher 4200 tape recorder. The word lists were read at a rate of 3 sec/word, followed by a brief 1200 Hz tone and the probe word. Each list was read into only one channel of the tape recorder, the channel assignments alternating randomly. There was a 20 sec response interval between lists. The entire test tape lasted 30 minutes.

**Subjects**

Ten aphasic men (aphasics) and another group of eight men matched for age and education (normals) served as subjects. The aphasics were all patients in the Speech Pathology and Audiology Services clinic of Northport Veterans Administration Hospital, New York. The aphasics were judged to have mild to moderate aphasia as tested on the Short Examination for Aphasia (Schuell, 1957) and the Porch Index of Communicative Ability (Porch, 1967). Etiologies included both trauma and cerebral vascular accidents occurring from 6 months to 19 years prior to testing. In all cases there were symptoms indicating brain damage to the left hemisphere and in a few cases to both hemispheres. Their ages ranged from 26 to 56 years (mean = 47.6 years) and all were right handed. Education levels achieved included eighth grade (n=4), high school diploma (n=5), and college diploma (n=1). All patients had audiograms that were normal in both ears for their ages.
The normals were all veterans who volunteered their time for the experiment. They all appeared to have normal language function and had no known hearing difficulties. They ranged in age from 41 to 65 (mean = 60.6 years) and were all right handed. The education levels achieved included eighth grade (n=3), high school diploma (n=3), and college diploma (n=2).

Procedure

The procedure was the same for both groups. The subjects were verbally instructed to report the word on the list that followed the probe word. A few practice word lists were read until the experimenter was satisfied that the subject understood the instructions or he was eliminated from the experiment. The subjects were told that the task was very difficult, but that they were to think about each word as they heard it and not to go over previous words. The experimenter recorded the verbal response of the aphasics whereas the normals wrote down the responses themselves. No particular difficulty was encountered in understanding the responses spoken by this group of aphasic patients because of their moderate impairment.

The tape-recorded lists were played on a Uher 4200 through Grason-Stadler TDH-39 earphones. The playback channels were equated for equal intensity and presented to subjects at a comfortable listening level.

RESULTS

The results were first tallied by the number of correct responses for each ear for each subject. Unfortunately, no differences in recall were obtained from right- versus left-ear presentations for either normals or aphasics. Indeed, replication of the Turvey et al. (1972) probe recall experiment for normals now seems in doubt (Turvey, personal communication). Therefore, the data presented in this paper combine the results from both ears.

Examination of the overall pattern of correct response by probe position yielded similar functions for all subjects but one, aphasic CH. His data are reserved for later and the functions showing probability of recall for the remaining subjects are graphed in Figure 1. For both groups of subjects the probability of recall is low and constant for the words near the beginning of the list and increases rapidly for the last three items.

According to the Waugh and Norman (1965) model, the probability of a word entering secondary memory or long-term store, P(LTS), is constant over all probe positions if rehearsal of each item is constant (as the subjects were so instructed). On the other hand, the probability of an item being retained in primary memory or short-term store, P(STS), is greatest for the most recently presented word and decreases monotonically for preceding words until it reaches zero when, presumably, the limited number of words stored in STS is exceeded. Assuming that the probabilities of a word being in LTS or STS are stochastically independent, then the probability of recalling a word at probe position 1 is:

\[ P(r_1) = P(LTS) + P(STS) - P(LTS)P(STS) \]

P(LTS) can be estimated over the constant portion of the recall functions by taking the mean of the recall probabilities at positions 2, 4, and 6. P(STS) is then calculated from the equation above.
Figure 1: Functions of the number of correct responses divided by the number of trials (probability of recall) at each position probed in the word lists for nine aphasic and eight normal subjects.
Figure 2 displays the estimated probabilities for both groups of subjects. The most striking feature of Figure 2 is that the probability of recalling a word from LTS for the aphasics is zero. The P(LTS) for normals (.11) is in range of those reported in Waugh and Norman (1965). The estimated probabilities for STS produced similar recency components for normals and aphasics, although the P(STS₄) is depressed by about .17 at positions 7, 8, and 9 for the aphasics.

Figure 3 presents the recall function for aphasic subject CH. CH's function contrasts sharply with the normals and aphasics in Figure 1. The probability of recall at all probe positions is nearly a constant .5 with no recency effect in the final items. In terms of memory models, CH has a high probability of recalling an item from long-term store, P(LTS) = .44, and no evidence of recalling an item from short-term store.

**DISCUSSION**

A number of possible disorders of memory function are implied by the results of this experiment. The majority of the aphasics studied (nine of ten) retained the same number of words in short-term store as the normal subjects. However, the aphasics were unable to recall the words correctly from STS as often as the normals. It should be noted that these statements cannot be generalized since only mild to moderate aphasics participated in this experiment.

For more severely impaired aphasics the instructions were too difficult to comprehend and presumably their memory processes might also be more impaired than those tested here. (Three moderately impaired aphasics were unable to comprehend the instructions.)

The results for STS agree with those obtained from the visual, serial search task of Swinney and Taylor (1971). Although some aphasics were unable to perform in their task, those who did were characterized as using a serial search process similar to normals, but more slowly and with more errors. These results are also in accord with the data shown by Carson et al. (1968:98). In the serial position curves obtained as an average of ten rote serial learning trials, the recency components for both aphasics and normals extend over the same number of items. However, the probability of recalling items is depressed for the aphasics.

In the probe recall experiment, nine out of ten aphasics were incapable of recalling words from long-term store. The conclusions of Carson et al. (1968:110) that aphasics learned tasks slowly and "demonstrated limited retention and transfer of learning in general" might be related to deficient recall of material from LTS. The question arises, however, as to what extent the disorder observed is caused by the registration versus the retrieval of words from LTS. Analysis of the errors in this experiment showed that aphasics responded occasionally with words in early positions in the word lists (numbers 1 to 5) as well as with words from previous lists. Apparently, some words were registered in LTS. Clearly further research directed at the nature of retrieval of items from LTS should be undertaken.

We can conclude that the majority of aphasics demonstrated memory disorders characterized by reduced short-term store function and an absence of long-term store function. On the other hand, one aphasic subject apparently had a complementary disorder--no STS function and a heightened LTS function. I have no reason to believe that CH's results are due to any artifacts surrounding his testing.
Figure 2: Estimates of the probability of words being recalled from long-term store or short-term store calculated from the functions presented on Figure 1 (see text).
Figure 3: Number of correct responses divided by the number of trials (probability of recall) at each position probed in the word lists for one aphasic subject.
or that he acted on different instructions than those given. (In informal testing with a graduate student I was unable to find a test strategy that could duplicate CH's results.)

We might be tempted to treat CH as an anomaly if it were not for the following studies. The study of two patients by Luria et al. (1967) is not directly comparable to the present study, but the patients did show strikingly different patterns of responses in auditory short-term memory tasks. Warrington et al. (1971) investigated three patients diagnosed as conductive aphasics. They concluded that these patients had relatively normal LTS function and severely impaired STS function for the auditory modality only. Strub and Gardner (1974) confirmed Warrington's results for another conductive aphasic. CH's results closely match those for the conductive aphasics except for the surprisingly high probability of recall from LTS. Unfortunately, CH stopped coming to the clinic and was not available for further testing.

We are thus left with the conclusion that aphasics differ from normals in both STS and LTS function, and further, that aphasics with different linguistic (and presumably neurological) deficits may have totally different memory disorders for auditorily presented words. We hope further research will clarify these statements and, in particular, incorporate the often observed memory differences for material presented in the auditory and visual modalities.

REFERENCES


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