THE ROLE OF AUDITORY FUNCTIONS IN REHABILITATION OF APHASIC INDIVIDUALS

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INTRODUCTION

We have for some time been extremely interested in auditory performances of aphasic patients. This interest has influenced both our clinical and our research programs. First, I will talk about what we have been doing clinically in an attempt to manipulate auditory processing by our aphasic patients, then I will mention some of our research interests related to auditory processes in aphasic patients.

For years, many aphasiologists have considered auditory functioning to be a highly significant component of aphasia, and they have stressed the importance of recovery of auditory function in rehabilitation of the aphasic patient. We have become increasingly convinced of the importance of improvements in auditory functions in recovery from aphasia; in fact, we feel that recovery of auditory functioning may be a prerequisite to the recovery of other speech and language functions, for a majority of aphasic patients. Accordingly, we have stressed auditory training (or retraining) in our clinical activities with aphasic patients. With some patients, we have administered programs which deal only with auditory abilities, with the expectation that, if auditory processes underly a major portion of speech and language abilities, we should see improvements in general speech and language abilities, even though auditory abilities were the only ones receiving formal retraining.

I will describe the treatment of two patients whom we placed in treatment programs which dealt exclusively with auditory function, then I will recount a few general observations and speculations regarding the influence of auditory functions on language abilities in general, and on aphasia in particular.

CASE REPORTS

The first patient was a 60-year-old man who suffered a CVA on January 11, 1970, at which time he exhibited speech impairment, weakness of the right lower face, and paralysis of the right arm and leg. He was referred to us from the Mayo Clinic and was admitted for treatment in our service on March 30, 1971, fourteen months after his stroke. Our examination indicated that he performed at the 62nd percentile, PICA Overall score; 45th percentile on Gestural subtests; 60th percentile on Verbal subtests; and 72nd percentile on Graphic subtests. He made 44 errors on 61 items in the Token Test. He also possessed a moderate bilateral sensorineural hearing loss. An interesting characteristic of this patient was the discrepancy between his auditory retention abilities and his auditory comprehension abilities. He was able to repeat long and relatively complex auditory commands but was unable to respond reliably to commands any longer or more complex than Level I of the Token Test.

The treatment program designed for this patient involved making motor responses to auditory commands. Three basic kinds of exercises were administered. In one, geometric figures, similar to those in the Token Test, were placed before the patient, and he was instructed to point to various combinations of the figures, with the number of items contained in the command increasing as his ability to perform correctly increased. In the second exercise, sets of pictures were placed before the patient, and he pointed to them as they were named. Again, the number of items named in each command increased as his performance inproved. A later version of this exercise involved pointing to pictures described by function. In the third exercise, pictures showing position, such as, behind, beside, etc., were placed before the patient, and he pointed to the appropriate picture as it was described, e.g., "the spoon is beside the cup."

The patient was in our service for six weeks, when he was dismissed with a home program made up of the described exercises to be administered by his wife. During this time in our service, his PICA overall score had changed from 62nd to the 92nd percentile. Verbal abilities had changed from 60th to 80th percentile, gestural abilities from 45th to 73rd percentile, and graphic abilities from 72nd to 99th percentile. His score on the Token Test had changed for 18 to 62 correct to 33 of 62 correct. Reading comprehension had increased from Grade 5.5 to Grade 6.5.

The second patient was a 36-year-old male who suffered a CVA in July, 1970. He was admitted to our service 13 months following his CVA. Examination results were as follows: PICA Overall, 76th percentile; PICA Gestural, 72nd percentile; PICA Verbal, 56th percentile; and PICA Graphic, 84th percentile. He made 15 correct responses to 62 items on the Token Test. Reading comprehension was below the 4th grade level.

The patient was placed in a home-based treatment program, administered by his wife. The treatment program consisted of auditory exercises using geometric figures similar to those used in the Token Test. In addition, a sentence repetition exercise was included in the program, using sentences of increasing length, presented on Language Master cards. For this patient, the choice of geometric figures in the auditory comprehension task proved to be unfortunate. The patient's performance gradually improved during the first month of treatment, then began to deteriorate. The report of the patient's wife, and our observations, suggested that the constant repetition of names and colors had caused them to lose their meaning to the patient. We then changed the stimuli to several sets of pictures. Performance recovered and began to improve gradually. Re-evaluation following three months of treatment indicated that several changes in performance had occurred: PICA Overall percentile, from 71st to 77th percentile; Gestural percentile, no change from 72nd percentile; Verbal performance, 56th to 86th percentile; and Graphic percentile, 77th to 81st percentile. Token Test scores changed from 15 of 62 correct to 22 of 62 correct in that same interval.

The results obtained with these two patients generally paralled those obtained with several other patients given similar treatment programs. Our results support the notion that improvement in auditory comprehension is accompanied by improvement in speech and writing abilities, at least for patients with pronounced auditory comprehension deficits. Whether such a relationship exists for patients with "Broca's aphasia" or "apraxia of speech" remains to be seen. Whether comparable training programs emphasizing speaking and writing exercises would result in comparable generalized recovery of function also remains to be seen. It is our feeling at this time that such programs will be less successful than auditory programs. Experimental validation of these speculations remains to be accomplished.

VARIETIES OF AUDITORY PROCESSING DEFICITS

Now, I would like to speculate about the varieties of auditory processing deficits that appear to accompany aphasia, their behavioral manifestations, and likely treatment procedures. So far, aphasic auditory deficits appear to fall into five general categories, which I am going to label "slow rise time," "noise buildup," "retention deficit," "information capacity deficit," and "intermittent auditory imperception." The first two originated, I believe, with Porch, the last, with Schuell. Let us consider each of them in turn.

Slow Rise Time

The patient whose auditory system is characterized by "slow rise time" tends to miss the initial portion of incoming auditory messages, because his auditory system requires longer than normal time to shift from a passive state to an active processing state. The situation is illustrated graphically in Part A of Figure 1. The patient's system "misses" the first few units of information, then performs efficiently. As long as the auditory input continues, the system continues to process

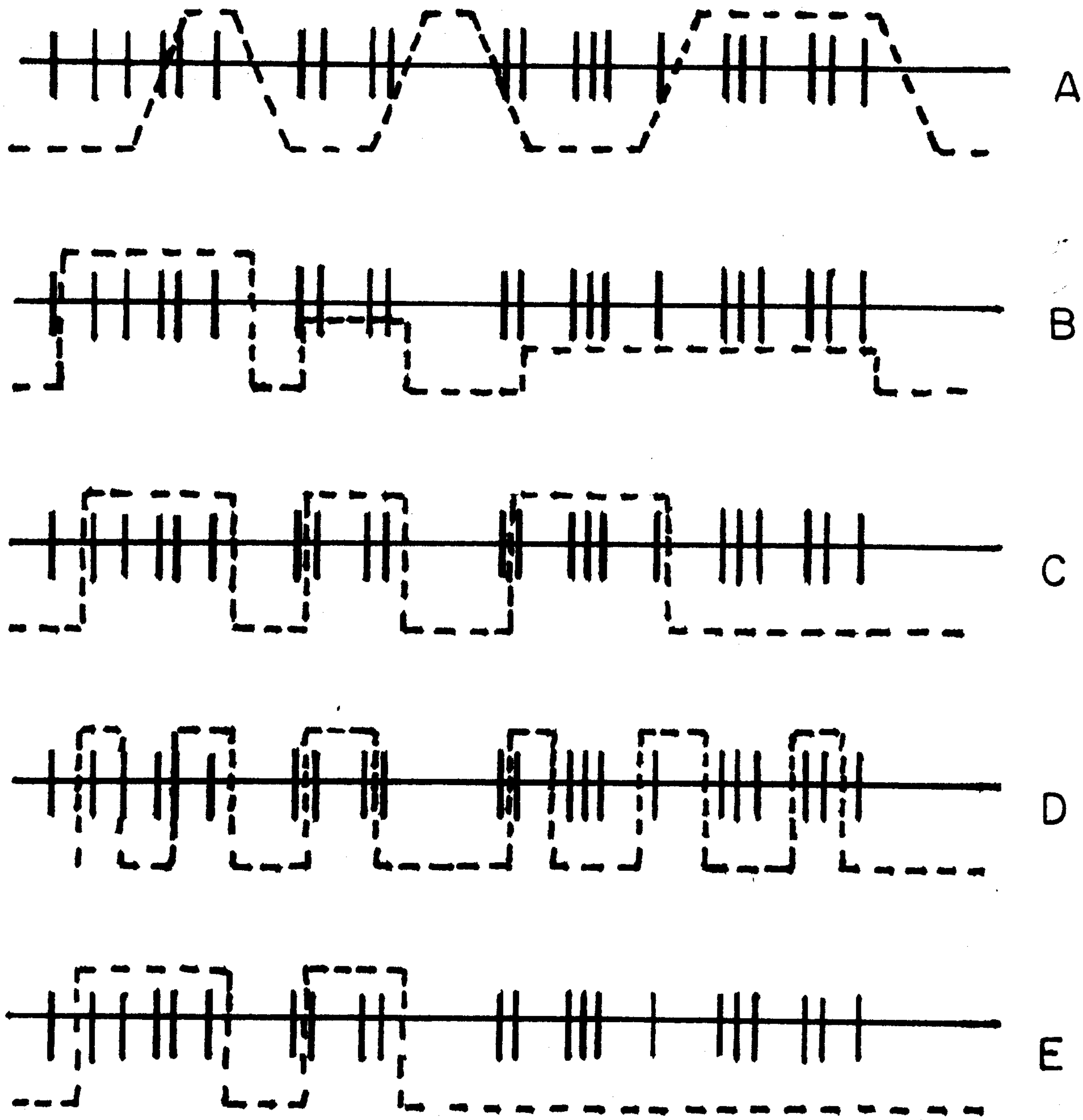

Figure 1. Graphic representation of various auditory processing deficits. The solid black line represents a series of incoming auditory messages. The dashed line represents the state of the individual's auditory processing system. The lower level represents a state of non-processing, and the upper level represents a state of active processing. Auditory deficits represented are: A, "Slow rise time;" B, "Noise buildup;" C, "Retention deficit;" D, "Information capacity deficit;" and E, "Intermittent auditory imperception."

efficiently. However, if the input stops, the system returns to a resting state, and the first few items in the succeeding message will be missed.

There appear to be two possible explanations for the "slow rise time" phenomenon. "Slow rise time" may result from a slowing in attentional processes; that is, the initial items in a series are missed because the patient has difficulty focusing his attention on the incoming messages. If this were the case, we would expect that if we placed a warning signal before the message, performance would improve. We would also expect that similar deficits would exist in other than the auditory modality. Another explanation for the "slow rise time" phenomenon postulates a generalized "inertia" of the auditory processing system, which results in decreased efficiency during the initial portions of incoming messages. If such "inertia" accounts for "slow rise time," we would not expect that provision of a warning signal would have much facilitating effect on the comprehension of ensuing messages, because a warning signal, requiring little more than perception, would probably not call for initiation of active processing. We might also expect that a generalized "inertia" would cause the processing system to remain in an active state for some time after the message had stopped coming in. If this were the case, then we would expect that if a series of messages were presented close together in time, auditory processing of the initial portions of messages after the first message or two should be efficient. Treatment for patient's with "slow rise time" would depend upon whether the deficits were due to "attention" or "inertia" factors. "Attentional" deficits could be treated by using warning signals prior to the delivery of auditory messages, with gradual decrements in the time interval between warning stimulus and message arrival. "Inertia" deficits could be treated by presenting a series of auditory messages with gradually increasing interval between successive messages in the series, forcing the patient to learn either to keep his system in an active state over relatively long inter-message intervals, or to activate the system in shorter time intervals.

Noise Buildup

The patient whose auditory system is characterized by "noise buildup" tends to respond appropriately to the initial portion of the auditory message, but he "loses" following portions of the message, as shown in Figure 1B. The rate at which the "noise" builds up appears to be related to the amount of processing required. Complex materials appear to generate the "noise" earlier in the message than do less complex materials. We would expect then, that if we gave such patients two messages, each of the same length, but one was more complex and required more processing, their performance would drop out sooner in the complex message than in the simple one. Treatment of such patients might involve exercises with messages of gradually increasing length and complexity.

Retention Deficit

The patient with "retention deficit" also exhibits poorer performance as message length increases. However, patients in this category do not appear to be so much influenced by message complexity or processing difficulty. Rather, they tend to "drop out" at about the same point in all messages, regardless of the complexity. Thus, the patient with retention deficit performs as poorly with repetition tasks as with comprehension tasks, while the patient with "noise buildup" performs better on repetition tasks than on comprehension tasks. Treatment of the patient with retention deficits would involve repetition or processing of messages of increasingly greater length.

Information Capacity Deficit

The patient with "information capacity deficit" possesses a system which, first, apparently cannot receive and process at the same time, and, second, processes smaller than normal units of the message. The performance of these patients tends to be alternately good and poor within a given auditory message. For example, if these patients are asked to repeat a series of words or a sentence, they tend to report the first and last elements in the series or the sentence, and leave out, or make errors on the middle elements. Their performance looks like the representation in Figure 1D. The performance of these patients improves if "blank" time intervals are inserted within the message at strategic points. These intervals evidently allow the patient to process message units as they occur, and allow him to process message units without missing units that come in while he is processing previous units. These patients are differentiated from patients with retention problems by the effects of time intervals placed within the message. When time intervals are placed within a message, patients with retention deficits do less well, while the performance of patients with information capacity deficits improves under the same conditions. Treatment of patients with information capacity deficits should involve messages with gradually decreasing intervals of "blank" time placed at strategic points within the message.

Intermittent Auditory Imperception

The patient with "intermittent auditory imperception" is the most difficult to discuss, because it seems as though his processing system is "fading" in and out in a sort of random fashion. His performance is similar to the representation in Figure 1E. Patients with this deficit may perform quite well on auditory comprehension tasks for relatively long periods of time. Then, without any observable changes in the characteristics of the task situation, the patient will begin to perform very poorly. Then, again without observable situational changes, his performance will return to its previous level. These "fade-outs" may last from a few seconds to several minutes, and the time between them may vary from a few minutes to several minutes. I am convinced that these intermittent imperceptions do not occur at random, but are correlated with situational or physiological changes. However, no one has yet been able to isolate factors which have much promise for explaining the phenomenon. Treatment for patients who exhibit this phenomenon is directed towards other areas of aphasic deficits, rather than to the intermittent imperception.

SUMMARY

In this presentation, I have attempted to convey some of our current thinking at Minneapolis Veterans Hospital regarding the nature of auditory deficits in aphasia, as well as suggesting possible modes of treatment. What I have said today contains large amounts of speculation, with little empirical evidence to support the speculations. The speculations are offered in the hope that they will stimulate thinking and discussion regarding the role of auditory functions in the rehabilitation of aphasic patients.