A Comparison Of The Processes Of Memory And Perception Between Aphasic And Non-Brain-Injured Adults

Brenda L. Adamovich

Braintree Rehabilitation Hospital
Braintree, Maine

Introduction. Psychologists and psycholinguists working in the areas of verbal learning and retention have utilized many techniques, particularly memory and forgetting, to study coding processes. Many theories have been formulated, mostly dealing with non-brain-injured individuals. There is little evidence concerning the likelihood and character of confusion in perception and recall of letters or digits of aphasic persons.

There are two basic approaches for the study of man's "information center." One involves the study of the anatomy and physiology of the nervous system, and the other involves the study of behavior (Locke and Kutz, 1975). Many investigators suggest that systematic errors of recall in immediate memory are indicative of the types of sensory coding used to hold material in storage. An investigation of immediate memory dealing with the psychological correlates of neurological systems which have undergone insult resulting in aphasia should provide insight with respect to the workings of systems of memory.

A qualitative theory of memory, the interference theory, is the currently dominant theoretical position. It accounts for forgetting with the explanation that other learning interferes with or prevents stimuli from being remembered (Marx, 1959). In immediate-memory research, the experimenter controls the input and the subjects express the output. Conrad (1970) suggested that the discrepancy between the two tells something of the "internal handling of information." Thus, systematic errors of recall would be indicative of the type of "sensory coding" used by the subjects "to hold the material in store." A comparison of the coding processes of aphasic persons to normal processes should provide information as to whether aphasic individuals function in a way similar to non-brain-injured individuals, yet at a lower level, or whether they function in a different manner altogether. Many assumptions are made about the way aphasic persons process information during the course of language therapy and this investigator wonders whether the therapists and aphasic persons are thinking ("processing information") in the same way. It seems that an aphasic person's method of interpretation or coding should be determined as a basis for therapy, because the coding or representation of an event in memory may also determine the effectiveness of certain kinds of clues for retrieval of that event. A retrieval system may function independently of a memory system. Supporters of this theory imply that memory deteriorates and causes the familiar lapses of memory of the elderly (Travers, 1970). The purpose of aphasia therapy is to facilitate recall rather than to re-teach aphasic individuals. Discovering an effective retreival mechanism would be of great value; hence the "retrieved idea" is important for many speech-language pathologists.

Memory is essential to communication. Constant patterns of errors of memory reflect errors in communication (Conrad, 1970). For this reason, a study of the errors of memory of aphasic individuals should be meaningful.

Purpose. The purpose of the study reported here was to determine, in immediate recall, systematic confusions in the mildly aphasic patient. These could not be attributed to errors of perception. The assumption is, the systematic errors of recall are indicative of the types of "sensory coding" used by subjects "to hold the material in store." The procedure calls for a three-part investigation: 1) an investigation of the perceptual confusions of the spoken names of the 26 letters of the alphabet when presented with a 0-dB signal-to-noise (S/N) ratio with no memory; 2) an investigation of the recall confusions when items were visually presented; and 3) an investigation of the recall confusions when items were presented auditorily. An important question was whether the letters which are confused in the auditory confusability test also confuse in immediate memory. Conrad's (1970) thinking that "regardless of the sensory nature of the input of the test material, when the moment for retrieval (recall) comes, in what form, state, code, image, etc., is the memory of the material stored or retained or held" is accepted by this investigator. If the aphasic subjects demonstrated normal identification of presented stimuli (errors of recognition are similar to those of non-brain-injured individuals) under non-delay conditions when stimuli are presented auditorily with a 0-dB S/N ratio, but impaired recall under conditions of delay, failures in memory were indicated. If the aphasic subjects were impaired on the non-delayed as well as the delayed conditions, perceptual and not memory processes might be the critical factor.

Hypotheses.

1. The names of the letters of the alphabet are not equally confused auditorily by non-brain-injured and aphasic individuals.
2. When the spoken names of the letters of the alphabet are presented auditorily with a 0-dB S/N ratio, there is no relationship between the errors in the responses of non-brain-injured individuals and aphasic individuals.
3. There is no difference in the immediate memory of groups of aphasic and non-brain-injured persons who respond to the "same" visual and auditory stimuli.
4. There is no systematic deviation from an equal distribution of responses to either visual or auditory stimuli in the immediate memory of aphasic and non-brain-injured persons.

EXPERIMENTAL PROCEDURES - PART I: PERCEPTUAL "CONFUSABILITY"

Preparation of Materials. Each of 10 untrained speakers spoke and recorded the names of 6 letters followed by a randomized set of the 26 letters of the alphabet. Speaking was in a conversational manner and the items were spoken at 5-second intervals. The first 6 letters would be used in practice. There were five female and five male speakers. Group I contained three female and two male speakers and Group II contained three male and two female speakers. A separate tape recording was made for each group of five speakers. The letters of the alphabet were randomized for each speaker.

Instrumentation. Each speaker was seated in an Industrial Acoustic Company (IAC) booth, and the recording was made using a Shure microphone (Unidyne

III Dynamic, Model 545) feeding a Magnecord, recorder-producer (Model 1022) operating at 7½ inches per second. Each of the speakers read the randomized letters of the alphabet at 5-second intervals, paced by a sweep-hand timer. The level of the subject's speech was monitored on the VU meter of the recorder to keep an approximately even level. The microphone was placed approximately six inches from the speaker's mouth and individual differences in speakers' vocal levels were minimized by adjusting the level of recording for each speaker.

The spoken letters of the alphabet recorded by the 10 speakers were continually monitored by the investigator in a playback mode (Magnecord 1022 recorder-producer to a Magnecord 1022 recorder-producer), and the maximum amount of deflection for each spoken letter was noted. The mean loudness level for each speaker was noted and the mean loudness level for each speaker was determined and an "on-average" equal amount of white noise was added using a Grason Stadler noise generator, Model 455 B. The speech samples were therefore prepared at a S/N ratio of O-dB with a continuous background of interfering noise on each of two tapes.

Methods of Presenting the Stimuli. Each of 20 non-brain-injured and 20 aphasic individuals listened to one or the other of the two recordings. Five aphasic men and five aphasic women listened to Tape I and the remaining five of each sex listened to Tape II. The same was true of the non-brain-injured group such that one-half of the women and one-half of the men listened to Tape I and the remaining halves listened to Tape II. Each subject, therefore, listened to five different speakers, each of whom spoke the 26 letters of the alphabet in a random order, or 130 letters spoken in conversational manner under conditions of S/N ratio of O-dB and a continuous background of white noise. The subjects were tested individually. Each heard the stimuli through a Plastic Molding and Engineering Company headphone set with TDII 39 elements. These fed a Wollensak T-1500 recorder operating at 7½ inches per second at a loudness level of 1.5 on the recorder dial. This level was considered to be loud enough to eliminate perceptual errors and still be a comfortable level for all subjects.

The subjects pointed to three-inch black gothic letters which were printed on a white card. The tester wrote their responses on a prepared response form. Forced guessing was required, eliminating omissions.

The error responses of each subject were scored in two ways: 1) the correct letter was marked beside each incorrect letter. The error responses of each subject were then arranged in a 26 x 26 matrix; and 2) a tally of the total number of errors for each subject was made.

Results of Perceptual Data Analysis. The individual matrices of each subject were combined to form two matrices, one for the aphasic group and one for the non-brain-injured group of subjects. The data in the matrices clearly revealed that the letters of the alphabet were not equally confused by the non-brain-injured or the aphasic individuals tested in this study. The data therefore justified rejection of the first hypothesis:

> The names of the letters of the alphabet are not equally confused auditorily by non-brain-injured and aphasic individuals.

The numbers of errors made by the groups of subjects in response to each individual letter were listed. A Pearson product-moment correlation between the errors made by the aphasic group and those made by the non-brain-injured group was computed to determine if there was a relationship between the types of acoustic errors made by the aphasic individuals and the types of acoustic errors made by the non-brain-injured population in response to each letter of the alphabet. A coefficient of correlation of .75 was obtained, significant beyond the 0.001 level. The data, therefore, justified rejection of the second hypothesis stated by the investigator:

> When the spoken names of the letters of the alphabet are presented auditorily with a 0-dB S/N ratio, there is no relationship between the error responses of non-brain-injured and aphasic individuals.

A table was made of the particular letters which were most often substituted for a stimulus letter when errors were made by the aphasic and non-brain-injured groups of subjects. Inspection of those data revealed that when an auditory error was made, the incorrect response letter "sounded like" or "rhymed with" the correct stimulus letter. The alphabet was divided into four "response groups." The letters within each group contained identical vowels as their syllabic nucleus when their spoken names were pronounced. This seemed to relate to articulatory, as well as auditory similarities. The four groups of letters within which error responses were made were: 1) letters having the vowel /i/ in common: B, C, D, E, G, P, T, V, and Z; 2) letters having the vowel /ɛ/ in common: F, L, M, N, S, and X; 3) letters having the vowel /e/ in common: A, H, J, and K; and 4) letters having the vowel/u/ in common: Q, U, and W. Thus, when the letter V was given as a stimulus, the subjects of both the aphasic and the non-brain-injured populations, most often substituted a B, C, D, E, G, P, T, or Z when an error was made rather than a letter outside this response group which might bear another kind of relationship with the letter V. Inspection indicated that the aphasic individuals and the non-brain-injured subjects reported identical error-response groupings, i.e., the four groups of letters each group having a common vowel. Thus, the data further supported rejecting the second hypothesis.

EXPERIMENTAL PROCEDURES TO INVESTIGATE CONFUSIONS OF IMMEDIATE MEMORY MATERIALS.

A vocabulary of eight letters was chosen and categorized into four different groups of three letters per group. Two groups, Group I and II, were constructed so that the spoken names of the letters (ay, bee, see, etc.,) were: 1) high in within-group aurally/articulatory "confusability"; 2) low between group aurally/articulatory "confusability"; 3) low within-group visual/shape "confusability." The remaining two groups, Groups III and IV, comprised of three letters each, were constructed, so that the spoken names of the letters within each group were: 1) high in within-group visual/shape "confusability"; 2) low in between-group visual "confusability"; and 3) low in within-group aural/articulatory "confusability." The aurally/articulatory relationships of the letters were determined in Part I of this investigation. Justification for the selection of the stimuli used in this study based on their visual/shape relationships is provided by the results of investigations conducted by Tinker (1928); Hodge (1962); Gibson (1964); Pew and Gardner (1965); Fisher, Monty, and Glucksberg (1969a); Fisher, Monty, and Glucksberg (1969b; and Reynolds and Hooker (1968). The spoken names of the letters in Group I: B, C, and V, contained the phoneme /i/; the spoken names of the letters in Group II: F, S, and X, contained the phoneme /ɛ/; the letters in Group III: V, X, and Y, contained vertical lines; and letters in Group IV: B, R, and S, contained curved lines.

Stimuli presented to the non-brain-injured individuals consisted of a set of 64 six-letter sequences which were prepared using the eight-letter vocabulary. These sequences were subdivided into two blocks of 32 sequences each. The order of letters was basically random but with a number of constraints: no letter occurred more than one time in any sequence; within each block of 32 sequences, each of the eight letters occurred equally often in each serial position and within each block; and every possible digram occurred at least once in each possible serial position. Stimuli presented to the aphasic individuals consisted of a set of 64 four-letter sequences which were prepared using the eight-letter vocabulary with the same constraints applied as were applied to the sequences presented to the non-brain-injured subjects.

EXPERIMENTAL PROCEDURES - PART IIA: VISUAL PRESENTATION OF STIMULI.

Materials. A 35-mm slide was made of each of the eight letters used in this study with one letter per slide. The letters were flashed singly at a distance sufficient to produce three-inch letters on a greyish screen.

Methods of stimulus presentation. Block I of six-letter sequences was presented visually to 20 non-brain-injured subjects (10 males and 10 females, age 50 and above). Block I of four-letter sequences was presented visually to 20 aphasic individuals (10 male and 10 female, age 50 and above). The letter sequences were visually presented, one letter at a time, by means of a frame-by-frame 35-mm Kodak slide projection. The projector was controlled by hand at an average rate of 60 letters per minute. A new letter thus appeared every second. After the last letter of a sequence, the experimenter stopped the projector until the subjects finished responding and were ready for the next sequence. Forced guessing was required to eliminate omissions.

EXPERIMENTAL PROCEDURES - PART IIB: AUDITORY PRESENTATION OF STIMULI.

Materials. Two acoustic recordings were prepared on which each of two speakers, one male and one female, recorded sequences of letters. On Tape I, three practice sequences of six letters each were recorded followed by the recording of 32 six-letter sequences in Block II. On Tape II, Block II of four-letter sequences were recorded (32 sequences).

Instrumentation. Both speakers were seated in an Industrial Acoustic Company (IAC) booth, and the recordings were made using a Shure microphone (Unidyne III Dynamic, Model 545) feeding a Magnecord Model 1022 tape recorder which was running at a speed of 7½ inches per second. Two separate recordings were made, two tapes, one consisting of four-letter sequences and the other of six-letter sequences. Each speaker read the four- and six-letter sequences in a randomized, alternating fashion, at the rate of approximately one letter per second with five-second intervals between sequences paced by a sweep-hand timer. A light switch was used to sound a click immediately before and after each sequence. The level of the speakers' speech was monitored on the recorder's VU meter during the practice session at which time the speakers' distances from the microphone were regulated to establish an approximately even loudness level.

Method of presenting the stimuli. The same 40 subjects (20 non-brain-injured and 20 aphasic) used in Parts I and IIA of this investigation served as subjects. The 20 aphasic individuals listened to the 32 four-letter sequences recorded on Tape II and the 20 non-brain-injured subjects listened to the 32 six-letter sequences recorded on Tape I. Forced guessing was required of the subjects to obtain a response for each stimulus.

A Wollensak T-1500 magnetic tape recorder fed a Plastic Molding and Engineering Company combination microphone headset-TDH 39 elements, through which the subjects heard the experimental stimuli. After the presentation of a sequence of letters, each subject responded by recalling all the letters of the sequence in the same order that they were presented.

Results of the memory data analysis. Tables of errors were made for each subject in which the errors made for each of the eight letters in the stimulus set were categorized into one of four groups. Group I consisted of error substitutions within the /i/ classification of stimuli letters (B, C, and V); Group II consisted of error substitutions within the /ɛ/ group of stimuli letters (F, S, and X); Group III consisted of error substitutions within the group of visually similar letters containing diagonal lines (V, X, and Y); and Group IV consisted of error substitutions within the group of visually similar letters containing curved lines (B, R, and S). Because the aphasic group had four letters per sequence and the non-brain-injured group had six letters per sequence, the total responses of the two groups were converted to proportions. The table took into account: type of subject (aphasic or non-brain-injured); mode of stimulus presentation (auditory or visual); and type of error response (within Group I, Group II, Group III or Group IV). The data were treated by analysis of variance in a design designated by Lindquist, Mixed Design, Type IV. The analysis revealed the following:

1. The difference, with regard to the number of errors, between the aphasic group and the non-brain-injured group yielded an F ratio of 14.97, significant beyond the .01 level of confidence. The aphasic subjects made more errors of recall than did the non-brain-injured group.

2. The difference between the mean number of errors made by the aphasic and the non-brain-injured subjects when different modes of stimulus presentation were used (auditory vs. visual) yielded an F ratio of 4.67 (1 and 38 d.f.), significant at the .05 level of confidence. Inspection of the data showed that the aphasic population made more errors when an auditory mode of stimulus presentation was used, whereas the non-brain-injured group were not affected by the mode of stimulus presentation and made approximately the same number of errors in response to each mode of stimulus presentation.

3. Considering the effect of the mode of stimulus presentation on the types of errors (aurally similar or visually similar), the non-brain-

injured group experienced more confusion, resulting in more errors, on letters in Groups I and II which contained aurally similar letters within each group during both the auditory and visual modes of stimulus presentation. The aphasic group, like the non-brain-injured, made more errors on the auditorily confusable stimuli Groups I and II, than Groups III and IV, during the auditory presentation of stimuli, however, when stimuli were presented visually, the aphasic individuals made more errors in response to stimulus letters in Group IV, which contained visually similar letters.

4. The effects of primacy and recency during the immediate recall process were evaluted by computing the number of sequences in which the first two letters of the sequence were reported correctly by a subject (primacy effect), as well as the sequences in which the last two letters were reported correctly (recency effect). Totals were obtained for non-brain-injured subjects and aphasic subjects during both the auditory and visual modes of stimulus presentation. Inspection of a summary table revealed that the non-brain-injured subjects showed the effect of primacy approximately 50% more often than did the aphasic subjects.

These data justified rejecting the third and fourth hypotheses:

> There is no difference in the immediate memory of groups of aphasic and non-brain-injured persons who respond to the "same" visual and auditory stimuli.
>
> There is no systematic deviation from an equal distribution of responses to either visual or auditory stimuli in the immediate memory of aphasic and non-brain-injured persons.

<u>Summary and Discussion</u>. A three-part investigation was conducted with 20 aphasic and 20 non-brain-injured adults serving as subjects in all three experiments: 1) subjects were required to identify the 26 letters of the alphabet, spoken in a conversational manner against a white noise background (0-dB S/N ratio); 2) sequences of letters were presented visually for immediate recall; and 3) sequences of letters were presented auditorily for immediate recall.

The aphasic persons made nearly twice as many errors as the non-brain-injured persons on all three tasks, suggesting perceptual and memory deficits. However, a number of highly significant parallel behaviors were seen between the two groups of subjects during the aural perceptual task. Analysis of the particular letters which were most often substituted for a stimulus letter when errors were made by the aphasic and non-brain-injured groups of subjects revealed that when an auditory error was made, the incorrect response letter "sounded like" or "rhymed with" the correct stimulus letter. Thus, when the letter V was given as a stimulus, the subjects of both the aphasic and the non-brain-injured groups most often substituted B, C, D, E, G, P, T, or Z when an error was made rather than a letter outside this response group which might bear another kind of relationship with the letter V.

Analyses of the errors made during the memory tasks revealed that coding processes used by aphasic and non-brain-injured adults to store information in memory were not the same. The non-brain-injured adults appeared to be using a speech code. Even though letters were presented visually for immediate recall, their errors "sounded like" or "rhymed with" the stimulus letter. The mode of the presentation of stimuli (auditory or visual), had no affect on the types of errors made by the non-brain-injured subjects. The errors of the aphasic group varied depending on the mode in which the stimuli were presented. If the letters were presented aurally, the errors "sounded like" the stimulus letter. If the letters were presented visually, the errors "looked like" the stimulus. This suggests that adequately functioning perceptual systems are present as the errors of memory of the aphasic persons were identical to the errors of perception (auditory and visual) which were reported earlier. This may have been due to a faulty system of coding or to no coding at all. This possibility arises from the fact that the mode of stimulus presentation resulted in different types of errors for the group of aphasic subjects. Although aphasic persons appeared to have adequately functioning perceptual systems, beyond this level of the processing of information, the aphasic individuals were not functioning in a way similar to non-brain-injured individuals. Aphasic persons did not seem to be using a speech code when storing information in memory. They also did not appear to be organizing information to facilitate recall, based on the finding that aphasic persons did not evidence the effects of primacy and recency as did the non-brain-injured group.

If memory is viewed as series of steps of processing such as: 1) a stimulus pattern arrives at a sensory apparatus which serves as a feature detector; 2) stimuli are coded in some way i.e., verbally, visually, semantically, etc., for storage in immediate memory; and 3) by an associative process, a representation of the letter in long-term memory is activated (Estes, 1972), the aphasic systems appear to be breaking down after step one. This suggests that therapy should concentrate on the development of the ability to code information if memory is to be facilitated. There may be several reasons for the lack of coding by aphasic individuals which hinder tasks of memory: a lack of the ability to discriminate sound; an inability to remember the name of the letters or to verbalize that letter; an inability to assign meaning to the letters; or the inability to organize information to facilitate recall. Aphasic therapy should include activities to work on the specific problem areas listed above to expand the person's overall memory capacity. Memory is essential to communication. Baddeley and Patterson (in Saxman, 1973) stated "A human being without memory would be a vegetable; not only would he be unable to communicate with or understand the world around him, but without sensory memory, he could probably not even perceive it adequately."

Further research is needed to investigate the efficacy of an organized therapy approach to facilitate memory.

References:

Baddeley, M.A., and Patterson, K., The relation between long-term and short-term memory. British Medical Bulletin: Congnitive Psychology, 27:237-242 (1971).

Chase, W.G., and Calfee, R.C. Modality and similarity effects in short-term memory. J. Exp. Psych. 8:510-514 (1969)..

Conrad, R. Errors of immediate memory. Brit. J. Psych. 50:349-359 (1959).

Conrad, R. Short-term memory processes in the deaf. Brit. J. Psych. 6:179-195 (1970).

Estes, W.K. An associative basis for coding and organization in memory. In: Coding Processes in Human Memory. A.W. Melton and E. Martin, (Eds.), Washington, D.C.: V.H. Winston and Sons, pp161-199 (1972).

Fisher, D.F., Monty, R.A., and Glucksberg, S. Visual confusion matrices: Fact or artifact: J. Psych. 71:111-125 (1969).

Gibson, E.J., Bishop, C.H., Schiff, W., and Smith, J. Comparison of meaningfulness and pronounceability as grouping principles in the perception and retention of verbal material. J. Exp. Psych. 67:173-182 (1964).

Johnson, Neal F. Organization and the Concept of a Memory Code. In: Coding Processes in Human Memory. A.W. Melton and E. Martin, (Eds.), Washington, D.C.: V.H. Winston & Sons, pp 125-160 (1972).

Liberman, A.M., Mallingly, I.G., and Turvey, M.T. Language Codes and Memory Codes. In: Coding Processes in Human Memory. A.W. Melton and E. Martin, (Eds.), Washington, D.C.: V.H. Winston & Sons, pp 307-334 (1972).

Locke, J.L. and Kutz, K.J. Memory for speech and speech for memory. J. Speech and Hear. Res. 18:176-191 (1975).

Marx, E. The Analysis of Sensations, New York: Dover, 1959.

Melton, A.W. and Martin, E. (Eds.). Coding Processes in Human Memory. Washington, D.C.: V.H. Winston & Sons, pp 59-84 (1972).

Miller, G.A. The magical number seven plus or minus two. Psych. Rev. 63:81-97 (1956).

Posner, M.I. Abstraction and the Process of Recognition. In: The Psychology of Learning and Motivation. G.H. Bower and J.T. Spence, (Eds.), New York: Academic Press, pp 43-100 (1969).

Reynolds, A.R. and Hooker, E.H. An evaluation of letter matching errors by adult aphasics. Proceedings of the Conference on Language Retraining for Aphasics held at the Ohio State University, October 12-22, pp 181-189 (1968).

Saxman, J.H., and Miller, J.F. Short-term memory and language skills in articulation deficient children. J. Speech and Hear. Res. 17:417-425 (1973).

Tinker, M.A. The relative legibility of the letters, digits, and of certain mathematical signs. J. Gen. Psych. 1:472-496 (1928).

Travers, R.M.W. Man's Information System. Chandler Publishing Co. PA, (1970).

Wickelgren, W.A. Short-term memory for phonemically similar lists. Am. J. Psych. 78:567-574 (1965a).

Wickelgren, W.A. Distinctive features and errors in short-term memory for English vowels. J. Acoust. Soc. Am., 39:588-593 (1965c).

Wickelgren, W.A. Distinctive features and errors in short-term memory for English consonants. J. Acoust. Soc. Am. 39:388-398 (1966c).

Wickens, D.D. Characteristics of Word Encoding. In: Coding Processes in Human Memory. A.W. Melton and E. Martin (Eds.), Washington, D.C., V.H. Winston & Sons, pp 191-216 (1972).

Wickens, D.D. MPA Symposium on Coding Processes in Human Memory. Memory and Cognition, 1:485-490 (1973).

Discussion.

Q. Did you take any short-term memory span measures of the two subject groups for visual and auditory information?

A. A pilot study was conducted to determine letter sequence lengths which would cause both groups (10 aphasic and 10 non-brain-injured subjects) to make errors, without overloading their systems with letter sequences which were too long, resulting in frustration and random responding. Less than three items for the aphasic group and six items for the non-brain-injured group resulted in complete recall by several members of each group. Since I was interested in the responses that were given when an error of recall was made, an additional item was added to each group. On the other end of the continuum, more than four items for the aphasic group and six items for the non-brain-injured group caused several subjects in each group extreme frustration and resulted in their rejection of the task.

Q. If you associate the pattern of errors with the possibility of code confusion in short-term memory, you have to make the assumption that it is in short-term memory to begin with. You do not seem to have a measure of the short-term memory span of the two populations and you are looking at results in terms of errors. The aphasic group made a lot of errors. How do you know that errors were due to not being able to process or code information? Perhaps the information was not in their short-term memory to begin with.

A. Terminology appears to be getting in the way. I am not sure what short-term memory is. Many investigators working in the area of memory reject the term altogether because of its vague nature and the differences of opinion regarding the time span of short-term memory; i.e., immediate, several seconds, etc. Another difficulty is the determination of when short-term memory ends and long-term memory begins. Because of these controversies, I chose the term immediate recall to compare how the subject groups dealt with information immediately after it was presented. I have explained why I chose four and six letter sequences. Assuming that the aphasic group once handled information like the non-brain-injured group and assuming that the non-brain-injured subjects are better communicators, it seemed that a systematic difference in the handling of similar information by the two groups would provide therapeutic implications for improving the communication of aphasic individuals.

The aphasic subjects did make more errors, which should not have occurred if letter sequence lengths were used which were of equal difficulty. However, if the aphasic subjects were not holding the letter sequence in immediate memory, the error responses should be random and should bear no relationship to the letters in the stimulus sequence. As I have reported, the aphasic responses were not random. The pattern of their responses yielded an F-ratio which was highly significant. Based on this finding, the aphasic subjects appeared to make more errors because it was too difficult for them to hold the material in store in the exact form that was presented (auditory or visual). Perhaps if they had gone one step further to code the information like the non-brain-injured did, they would have resulted in a fewer number of errors. If the aphasic group had utilized all the strategies of the non-brain-injured group, i.e., coding, chunking, primacy effect, recency effect, etc., perhaps they would have been able to handle six items instead of only four. Hopefully, further research will provide these answers.

Q. What was the interval in the auditory condition between the last item of the list and your probe or selection?

A. Responding immediately followed the presentation of the last stimulus.

Q. You say you found no primacy or recency effect?

A. The aphasic group evidenced significantly decreased primacy and recency effects when compared to the non-brain-injured group.

Q. Why did the normals make so many errors in the perceptual part of the study? Was it because of the signal-to-noise ratio?

A. I would imagine. Also, the age of the subjects might have further complicated the listening task.

Q. In memory studies, did you ever think of going back one step in doing a recognition phase where you would ask the question "Have you ever seen this before?" instead of "Do you remember this?"?

A. This was also done as a part of my pilot study. A determination was made that all subjects had adequate visual and auditory reception and perception of the letters used as experimental stimuli.

Q. How do you feel about using serial stimuli? It has been suggested that the way we recall something has a lot to do with the way we initially learn it. Asking someone to tell you the months of the year is not a difficult task unless you require the person to name the months in alphabetical order. Aphasic individuals, like normals, have learned the alphabet in a certain way. Perhaps stimuli other that serial stimuli might have been a better choice.

A. Selecting the best stimuli to study memory is difficult. I did not choose words because it was so difficult, if not impossible, to control for the semantic implication of each subject. Letters were chosen merely because they had a standard auditory and visual component which could be controlled for. I have never really thought about the effect of serial learning on recall, but it seems that this actually might validate that spoken letters do have primarily a visual and aural component rather than a variety of semantic components. The nature of serial learning generally does not result in semantic application.

Possibly, by helping an aphasic person deal first with the easier-to-control confusions or redundancies of letters, he will be better prepared to deal with the more complicated redundancies in his language system.