Microcomputerized Auditory Comprehension Training

Russell H. Mills
Veterans Administration Medical Center, Ann Arbor, Michigan

The present day work environments of many speech pathologists reflect the economic characteristics of the time in which we live. While the U.S. population grows older and more susceptible to disorders which produce aphasia, there is a push to reduce the costs of health care delivery. To the speech pathologist this may mean operating in a clinic with fewer therapists than is needed, seeing more patients than is desirable, seeing a patient less frequently than is desired, or not treating a given patient at all. One means of partially relieving this situation is to make our clinic operations more efficient. This paper will address itself to the issue of increasing therapeutic efficiency in auditory comprehension training through the use of a microcomputer. At no point will the paper suggest that this technique can or should replace traditional therapy. Rather, it is a means for increasing our impact by reaching greater numbers of patients and providing greater amounts of therapy to the patients treated.

Attempts have been made to expand the therapist's impact through the use of teaching devices such as Language Master and PAL systems. However, these devices have had only limited utility. To be successful an automated device must meet at least four criteria. The system must be able to 1) analyze patient responses and provide appropriate feedback, 2) collect, store and analyze patient response data, 3) be cost effective, and 4) produce highly intelligible speech.

A minicomputer recently was applied to the teaching of spelling to aphasic patients (Seron, Deloche, Moulard and Rouselle, 1980). The procedure was partially successful in that it demonstrated that computer systems could analyze patient responses and collect, store and analyze data in a typed spelling task. However, the minicomputer used was far too expensive for most clinics to acquire (Criterion 3), and most clinics do not have access to such a unit on a timesharing basis. Also, the computer was not supported by the peripherals necessary to allow it to produce speech (Criterion 4). Any computer system that is designed for aphasia therapy must also overcome these two limitations--cost effectiveness and speech production. In seeking to reduce the costs associated with minicomputers one may be led to the microcomputer for a solution. While most clinics cannot afford a larger computer, many can justify the cost of a microcomputer system as a therapy tool. Secondly, finding a solution to the speech production problem has not proven difficult because of the array of speech synthesizers and digitizers which are available to support the popular microcomputer lines.

We acquired a system which allowed us to begin creating programs for the treatment of auditory comprehension problems using a microcomputer. We chose to begin with auditory comprehension because we believe it to be a fundamental problem for many aphasic persons, and one which presently requires direct clinician participation. The system selected consists of an Apple II-Plus 48K microcomputer with dual disk drives, Zenith color monitor, Mt. Computer clock card, Mt. Computer Supertalker, Apple Graphics Tablet and EPSON MX80 printer.

The auditory comprehension programs presented today are Word Rec I, II and III. All execute in a similar manner and are programmed in Applesoft Basic. Execution of Word Rec I begins with the presentation of instructions to the patient. These are presented via text on the monitor screen and are spoken by a Supertalker phrase table. The program then loads the first plate of four colored and numbered pictures onto the monitor's screen. Then a second Supertalker phrase table is loaded which will speak the stimulus item names and provide spoken reinforcement. The Supertalker then speaks the carrier phrase and the first stimulus item (e.g., "Find the chair."). The patient's task is to select from the four numbered pictures on the screen the one whose name has been spoken. If he is unsure of the answer and wishes to hear the stimulus again he pushes the Return key for a repeat. If a repeat is not needed the patient responds by pressing a digit from 1 to 4 corresponding to his choice of the numbered pictures on the screen. Following a Return press, the system evaluates the response. If correct, the Supertalker randomly speaks "Good" or "Right." If the first attempt is incorrect it speaks "Wrong, try again" and the stimulus is repeated. After a correct response or two errors he is shown the correct choice by the flashing of a Hi-Res box around the correct choice. Between stimulus items the program saves the response data in a text file (WR Data) for later reference. The program consists of 12 items, though it can easily be expanded if required by the needs of a patient. Word Rec II and III differ only in that each stimulus consists of two and three items, respectively.

Earlier we based our justification for the use of our computer system on the fact that patients are not getting all the therapy needed. If our system and its auditory comprehension programs are to be of practical value they must allow patients to perform with total independence, freeing the clinician to see other patients or to perform other duties. Also, the clinician must have access to performance information after the patient has completed his therapy session with the computer. Without some type of data collection procedure the system would be without value in terms of increasing efficiency. The text filing procedure we have used fills the need for data collection. When the clinician wishes to review a patient's performance the WR Analysis program is executed which analyzes the data which were stored in the WR Data text file. The data can be displayed on the CRT or on the printer at the clinician's request. The program provides extensive performance data, summary statistics, and a summary of the patients' performance across sessions. These data have proved to be valuable in assessing patient progress as well as for research purposes.

The auditory comprehension programs have been used with several aphasic patients at our VA Medical Center. The following data represent the performance of a single patient who has worked with the system for the longest period of time--13 months. C.M. was a 39-year-old computer programmer when he had an occlusion of the left internal carotid artery in September of 1979. His CVA left him with dense global aphasia, right hemiparesis and field cut. During his treatment at another medical facility his aphasic symptoms cleared somewhat during the first three months However, he still remained severely involved in all modalities. At six months post onset he began treatment in our facility. At 16 months post onset he began to work with the computer system on auditory comprehension. Table 1 provides data about this patient's performance on the auditory comprehension tasks. He began Word Rec I at a high level of proficiency

(91.6%) and improved to errorless performance. His use of the repeat feature dropped to zero. C.M.'s initial performance level on Word Rec II at baseline was 58.0% with eight repeats. Percent correct increased and repeats decreased until errorless performance was achieved in October, 1981. The pattern of performance shown for Word Rec III is less clear. C.M.'s performance dropped between baseline and the first probe point (3/81) but then steadily increased. The use of the repeat feature dramatically increased on the first probe, though his performance level fell. Use of the repeat continued to increase at the second probe and then began a steady decline.

Table 1. Auditory Comprehension Task Performance.

Date	Word Rec I	Word Rec II	Word Rec III
01/81	91.6% (4)*	58.0% (8)	10.0% (2)
03/81	91.6% (0)	83.0% (2)	0.0% (22)
05/81	100.0% (0)	91.6% (1)	41.6% (33)
10/81	100.0% (0)	100.0% (0)	66.6% (10)
02/82	100.0% (0)	100.0% (0)	83.0% (8)
Change	+8.4%	+42.0%	+73.0%

* = the number of times the repeat was used.

C.M. showed improvement on all levels of task difficulty. However, the results did not indicate to what extent the improvement may have generalized to other comprehension activities. To answer this question his performance on the auditory comprehension subtests of the PICA and on the Token Test was measured (Table 2). The results show steady increases in PICA auditory comprehension subtest scores. There also was improvement in Token Test scores, but in less regular fashion. Token Test scores remained relatively constant until probe number two when they increased to the 31%tile. From that point on they increased only another two percentile points. These results indicate that the improvement noted in the computerized auditory comprehension tasks did generalize to untrained auditory comprehension tasks. However, no objective data were available to estimate the degree of effect this improvement had on functional communication. Spontaneous subjective reports from the family indicated that C.M. did improve in his functional comprehension abilities.

In summary, the system has demonstrated its potential for increasing clinical efficiency through the use of automated auditory comprehension training. These results suggest that this microcomputerized training program was capable of producing positive changes in the auditory comprehension abilities of this chronic aphasic patient. These data further indicate that treatment effects generalized to the auditory comprehension portions of the PICA and the Token Test. It is likely that improvement also generalized to the functional use of auditory comprehension, because the family has reported improved comprehension in the home. While it is doubtful that this or any form of treatment will restore this individual to his former employment, it appears to have improved his quality of living, which is a reasonable measure of the worth of our therapies.

Table 2. PICA subtest VI and X scores and Token Test percentiles.

Date	Subtest VI	Subtest X	Token Test Percentile
01/81	8.6	12.4	10
03/81	9.5	13.0	13
05/81	10.2	14.0	31
10/81	12.2	14.4	34
02/82	13.4	13.9	33
Change	+4.8	+1.5	+23

REFERENCES

Seron, X., Deloche, G., Moulard, G. and Rousselle, M., A computer-based therapy for treatment of aphasic subjects with writing disorders. Journal of Speech and Hearing Disorders, XLV, 45-58, 1980.

DISCUSSION

Q: Have you ever thought about adding flexibility to the programming you have now by changing the input parameters of the message delivered to the patient? Are you capable of doing that with basic language?

A: There are certain parameters you can change, for example, the presentation of text. We have a selection where you can duplicate the carrier phrase and stimulus item in a visual mode. You can select that or deselect that as you wish. The method we are using to generate speech is a speech digitizer. The way that it works is this. You input a waveform and it samples it at a given rate, in this case 4,000 times/second. This is stored as digital information. So you have individual words stored in a phrase table and you can group them anyway you wish. Doing that makes intonation a very difficult thing to control unless you have enough room in the phrase table to store different inflection patterns for the same word. The fact of the matter is that speech digitization eats up memory so fast (4K/second) that it becomes very difficult to control those kinds of parameters.

Q: Would you argue for using larger systems?

A: That would be one way of handling it. I would not argue for use of speech synthesis because these patients already have difficulty with comprehension and using a distorted signal, such as syntehsized speech, would only compound the problem.

Q: My point is that as therapists one of our goals is to maximize input to the patient and we can do that through a number of ways such as temporal aspects, pauses and prosody. I think that if a computer program is to be applied to a wide range of aphasia patients it has to have that flexibility.

A: I would agree with you that that is certainly desirable. I think that with microcomputers we are limited in how much of that we can do.

Q: How feasible is it to outboard a tape recorder which is controlled by the microcomputer? It seems that that would be a much more flexible vehicle for delivering auditory stimuli than either synthesis or digitized speech.

A: That is a technique which is easily used, but the problem with linear storage is that when you present a stimulus and want to then use a specific reinforcer, there may be delays in accessing the appropriate point on the tape. This is also true for conditions where repetitions are called for which require stopping and starting the tape.

Q: One of the problems I see with the microcomputer is the availability of software. How do you see that being handled in the area of aphasia? Do you see clearing houses for software exchange?

A: There is not much available yet. When we first got our system I looked for programs for our aphasic patients. I ended up looking in the early childhood learning area. Most of the programs I found were inappropriate. Since that time things have started to change in the closed head injury area where there is some very good software available. In the aphasia area not much is presently available, because commercial programs are directed toward larger consumer markets.

Q: What types of problems have you had in teaching the patient to use your equipment?

A: Our biggest fear was that we might not be able to get the patient to interact with the keyboard. Numerous times we were told that modifications such as separate switches or a touch sensitive screen would be necessary. We have not found this to be a problem. Patients are able to interact with the keyboard. In these programs the interaction is fairly simple; select from the numbers, 1 to 4, and push return. I have not had a problem with patients with visual field cuts. The patient you saw on the tape had a field cut but has compensated for it quite well.

Q: He (the videotaped patient) had some long delays when he was trying to choose his response. What did he have to do in response?

A: He had to push three numbers in the sequence in which they occurred and then push return.

Q: Do you think that that had some inherent difficulty in it?

A: Well, initially I noted with this patient that we had to go through some fairly extensive training. He had three or four sessions of practice interacting with the keyboard. Beyond that he was able to handle it all right. The fact that some of his latency may be due to that difficulty is a possibility.

Q: How can we tell the difference between a problem with the keyboard and a problem with auditory comprehension?
A: Well, if you are interested in teasing that out you could simplify the response characteristics as much as possible. You could build some outboard switches or equip the computer with a touch-sensitive screen so it becomes a pointing task.

Q: What is your feeling about how the patients feel about working with the computer?
A: The responses we get are, for the most part, positive. I think there is something to be said for patients working at the edge of technology. The patient I described today was a computer programmer and really enjoys it--perhaps because it may help him to feel like he is still able to do something related to his past employment.

Q: You mentioned genralization to functional comprehension tasks. Have you considered programming more functional comprehension tasks?
A: I would like to, but it becomes difficult because of the constraints on speech. Unless we can increase the memory in some way I don't see that happening with the present equipment.

Q: The quality of digitized speech is much better than synthesized speech. Is it much more expensive?
A: No it isn't. The speech digitizers and synthesizers for the Apple cost about $250.00 to $300.00 each. So they are no more expensive.

Q: How much does such a system cost?
A: The system costs between four and five thousand dollars. The cost depends upon how much program development you wish to do. We have some components on ours which you could do without. There are some other systems available, such as the Atari 800 which is being used in the closed head injury area. The cost is in the neighborhood of $1,200.00. The lower cost systems are often limited in some capabilities such as speech digitization. For this reason, we have steered clear of these units.

Q: Could the response demands be decreased through use of a light pen?
A: We thought that would be another solution so we got one. We tried to program it and ran into some memory problems. At that point we didn't feel that the response problem was sufficient to warrant compromising the programs. So we have not pursued it further.