A Self-Modifying Computerized Reading Program for Severely-Impaired Aphasic Adults

Richard C. Katz and Vivian Tong Nagy
Veterans Administration Outpatient Clinic, Los Angeles, California

The benefit of computers in aphasia rehabilitation depends on how well we can instruct the computer to do what we think best in a given situation. It's "high-tech" all right, but is it therapy? Treatment software should reflect principles and procedures that, in our experience as clinicians, are effective for improving the communicative abilities of aphasic patients. One common approach to treatment is to provide patients, whenever possible, with the opportunity to respond with a high degree of accuracy and success, but at a level where a certain degree of language processing is required; that is, where new learning is required or new strategies are practiced.

This has been accomplished in various ways within several computerized treatment studies. Mills (1982), Katz and Nagy (1983) and Loverso et al. (1985) have described treatment programs consisting of several levels, working from easy to difficult. However, changing levels in these programs had to be initiated by the clinician, who evaluated performance and then ran a different program or disk. Katz and Nagy (1984) reported on a typing and writing program, Speller, that presented a hierarchy of six cues to facilitate spelling the names of objects. Cuing was provided in response to errors, but some patients had to make several errors, working their way down the cuing hierarchy for each stimulus at each session, before the cues provided sufficient information for the patients to respond correctly. A better approach, like the one used in the studies above, would be to design the task so that patients could maintain a high degree of accuracy while the task gradually and systematically became more difficult.

The objective in this study was to focus on improving functional reading in severely impaired aphasic patients. We developed and tested a computer program designed to teach comprehension of 12 single, semantically-related words to five severely impaired aphasic patients. These words might ultimately be used on a communication ("pointing") board for these patients. The program began with a relatively simple word discrimination task and gradually became more difficult. Patients were initially required to match one of two printed words to a picture. The program contained two features we felt would improve the ability of these patients to recognize and understand the target words. First, the level of difficulty, that is, the number of multiple choices displayed with each picture, was automatically adjusted by the program within the session and from session to session, in response to the patient's performance, so that the patient would maintain a high degree of accuracy. Second, at the end of each session, the program generated and printed out on paper four different writing activities for the patient, based in part on the patient's performance during the session.

PROCEDURE

This study was a single-case design with five adult male subjects. Each subject suffered a single occlusive left CVA of at least two years duration that resulted in severe aphasia. Descriptive information is displayed in Table 1.

Table 1. Subject description.

SUBJECT	AGE	EDUC	YPO	PICA OA	PICA RD
1	66	12	9	49	31
2	75	12	2.3	17	19
3	54	12	14	29	25
4	79	12	13	30	44
5	57	12	2.2	49	64
Average	66.2	12	8.1	34.8	36.6

In order to measure the effect of the program on the patients' ability to read the same words in a more traditional, noncomputer setting, patients were presented with pictures of the twelve target objects at the beginning and at the end of the study. Each picture was shown and the six corresponding multiple choices used in the program were printed below the picture. The patient was asked to "point to the word that is the name of the picture." For purposes of reliability, this procedure was done a total of four times, twice before computer treatment was begun and twice after the program was completed. Performance feedback was not given to the subjects during or following administration of these tests.

Following the pretreatment measure, subjects were trained independently to run the computer treatment program. Twelve separate computer-generated line drawings were displayed on the screen, one at a time. As each picture was displayed, two to six words were printed below the picture -- the correct word plus one to five foils (incorrect choices). All subjects began the task with two multiple choices showing. The patient was prompted to "find the word that is the name of the picture." The patient then indicated the word by pressing the single key (number 1 through 6) associated with his choice. Whenever a correct response was made, positive feedback was provided and the next stimulus picture and set of words were displayed. If a response was incorrect, auditory feedback was given, and the multiple choice field was reduced for that picture by one foil to make the correct choice easier. If the response was wrong with only one foil displayed, then feedback was provided, the correct choice was shown, and the patient was directed to go on to the next item. All responses were automatically stored on disk.

During the first computer session, two multiple choices (the correct word and one foil) were initially shown for each stimulus. At the beginning of each subsequent session, the computer program adjusted the number of foils initially presented with each picture in response to performance accuracy of the previous session. Specifically, when the patient correctly responded to 11 or 12 items out of the 12 stimuli (that is, 92% or better) on the first attempt, the number of foils initially displayed during the next session was increased by one, and the task for that session became more difficult. Conversely, the number of foils was reduced by one on the following session and the task made easier, when the patient answered 8 items or less correctly (74% or less) on the first try. The number of foils remained the same from one session to the next if the patient correctly answered 9 or 10 items on the first try (between 75% and 83%). Six multiple choices (the correct choice plus five foils) were shown for each stimulus at the most difficult level.

Foils #1 and #2 were visually similar to the target word; foils 3, 4, and 5 were semantically similar to the target word. The position of each multiple choice on the screen was randomized. Criterion for termination of the task was two sessions of 100% accuracy at the highest level (that is, six multiple choices). The task was terminated if criterionwas not reached within 16 sessions or at the subject's request.

In addition to systematically adjusting the number of multiple choices, the program provided homework via the printer in the form of four graphic tasks that included copying and matching words and unscrambling anagrams. All words were used in the homework tasks, but words that generated incorrect responses during the session appeared twice as frequently in the homework as words that had not generated errors.

RESULTS

Table 2 shows the average percent correct for identifying the names of the twelve pictures presented twice pre- and twice post-computer treatment. Four of five subjects demonstrated improvement at this reading task, with three of the subjects showing considerable change. The two subjects who showed little or no improvement on the task were a Wernicke's aphasic patient and a transcortical motor aphasic patient. Subject #2, a Wernicke's aphasic patient and the subject with the most severe reading impairment, showed no improvement on the pre- and post-test or on the task itself. The task appeared too difficult even at the lowest level of two multiple choices; it took him 13 sessions to achieve the accuracy necessary to progress to three multiple choices and then his poor performance on Session 14 dropped him back down to two multiple choices. Subject #1, a transcortical motor aphasic patient, demonstrated a little more change. His performance on the reading test improved by only two words, and little improvement was observed on the task itself, where performance was very good with two multiple choices, but consistently poor when the number of choices was raised to three. Clearly, the computer program as presented was not appropriate for these two patients.

Table 2. Percent correct for identifying the names of 12 pictures from a field of 6 multiple-choice words each.

SUBJECT	PRE-TX	POST-TX	CHANGE
1	42	58	16
2	42	42	0
3	46	100	54
4	58	92	34
5	71	100	29

Subjects 3, 4, and 5, all Broca's aphasic patients, showed considerably more improvement. These subjects all performed well on the treatment task, with most session scores averaging between 92% and 100% accuracy as the number of multiple choices increased steadily from session to session. The largest amount of change on the pre- and post-treatment test was demonstrated by subject #3, who improved on the pretest and posttest by over six words.

This study has provided some useful information regarding computer assisted therapy for aphasic adults. First, the lack of improvement for the

two most severely-impaired subjects highlights the limitations of this version of the treatment program. This approach was certainly more appropriate for the three remaining subjects, whose performance closely approached or achieved 100% accuracy. Their occasional errors at higher levels frequently demonstrated semantic confusion; for example, SPOON for FORK. However, cues and homework focused on visual factors, such as anagrams, copying and matching, and not on contrasting semantically related words. Future modification of this program or similar progams should provide additional treatment contingencies for the visual problems of the most severely impaired and the semantic problems of the higher level patients. Additional factors, such as the number and relevance of stimuli, can be controlled for each patient to improve patient performance and program usefulness. Computers are becoming effective treatment tools. This study demonstrates the value of a procedure for automatically adjusting the level of task difficulty as a function of performance in computer programs.

REFERENCES

Katz, R.C. and Nagy, V.T. A computerized approach for improving word recognition in chronic aphasic patients. In R.H. Brookshire (Ed.), Clinical Aphasiology: Conference Proceedings, 1983. Minneapolis, MN: BRK Publishers, 1983, 65-72.

Katz, R.C. and Nagy, V.T. An intelligent computer based spelling task for chronic aphasic patients. In R.H. Brookshire (Ed.), Clinical Aphasiology: Conference Proceedings, 1984. Minneapolis, MN: BRK Publishers, 1984, 159-165.

Loverso, F.L., Prescott, T., Selinger, M., and Smith, R.D. The application of microcomputers for the treatment of aphasic adults. In R.H. Brookshire (Ed.), Clinical Aphasiology: Conference Proceedings, 1985. Minneapolis, MN: BRK Publishers, 1985.

Mills, R.H. Microcomputerized auditory comprehension training. In R.H. Brookshire (Ed.), Clinical Aphasiology: Conference Proceedings, 1982. Minneapolis, MN: BRK Publishers, 1982.

DISCUSSION

Q: I'd like to ask whether or not you see the increasing sophistication of computer graphics, with Macintosh, the paint program and so on, as providing us more ability in presenting purely visual stimuli with the computers, whether or not that is practical as a clinical tool?

A: Yes, computer applications in our area will increase as graphics ability improves. The first study presented at this session using the Raven's Coloured Progressive Matrices showed one way sophisticated graphics could be useful by producing detailed drawings. Another powerful but rarely used form of graphics is animation, perhaps more relevant to the Loverso et al. "verbing" study, also presented at this session. The quality of computerized graphics continues to improve. Recently, inexpensive visual digitizers use video cameras, or other visual input devices, along with software, to produce realistic visual images, that look similar to photographs. These digitized images can be stored within the computer's memory, manipulated by programs and then saved on disk for later use. To accomplish these things, the capacities of computer memory and disk storage space must be substantial. The Macintosh is presently the best machine for utilizing digitized images, although the graphics capacity of

the Apple II is more than adequate. The increased memory and storage capacity also permits development of more complex and sophisticated programs that can make many clinical decisions and incorporate many of the more important elements of treatment.

Q: Your paper seems to suggest that a linear relation exists between difficulty and the number of choices. Do you feel there really is that kind of relationship? Or are four as easy as six for some patients?

A: For these five patients, we felt that as more multiple choices were presented, the task for them became more complex. We also found that when the foils changed from visually confusing to semantically confusing, some subjects experienced additional problems, as they were confronted with a somewhat different problem, similar to changing sets on the Raven. What we were trying to emphasize with the program was that the program would remember from session to session how the subject was performing and adjust the difficulty of the task so that the subject would not have to start at square one each time the program was run. Previously obtained information relevant to performance was not ignored, and the subject immediately received an appropriate level of cuing.