CHAPTER

23

A Comparison of Computerized Reading Treatment, Computer Stimulation, and No Treatment for Aphasia

Richard C. Katz
Robert T. Wertz
Susan M. Lewis
Cami Esparza
Muriel Goldojarb

Recent reports have demonstrated that microcomputers can provide effective reading comprehension treatment to aphasic adults (e.g., Katz and Nagy, 1985). However, four major problems exist in interpreting computer treatment research. First, aphasic subjects who receive computer treatment are usually also participating in traditional clinician-provided speech treatment. Experimenters attempt to minimize this influence by discontinuing concurrent clinician-provided treatment that focuses on the same skills and modalities required for the computer program. However, no computer treatment study has eliminated concurrent clinician-provided treatment during presentation and assessment of the experimental computer treatment.

Second, no computer study has used a randomly assigned no-treatment control group for comparison with the treatment group. The test of any treatment's efficacy is to select similar patients who share important characteristics and assign them randomly to treatment and no-treatment groups.

Third, the contribution of general, nonspecific stimulation provided by frequent use of the computer has not been measured and compared with the effects of structured, computerized language treatment. Some authors (Enderby, 1986; Lynch, 1983; Malec et al., 1984) have considered the impact of computer games on communicative, cognitive, and social factors in brain-injured patients. Repeated sensory stimulation and the novelty of the computer medium could, in themselves, contribute to changes in patient behavior.

Fourth, computer treatment programs that are comprehensive, multilevel, and fully automated have not been tested with aphasic patients. While complex, multilevel programs have been reported, some programs are limited in scope and others require frequent intervention by the clinician. The greatest potential for treatment software lies in the ability to program a large number of related, hierarchically arranged tasks that respond to patient performance in much the same way a clinician works through and modifies a treatment plan.

This study was developed in response to these problems. Its purpose was to create and evaluate the effectiveness of a comprehensive computer program for providing hierarchically arranged reading treatment to chronic aphasic patients who were *not* receiving any other speech and language treatment. The program presents reading activities in a standard match-to-sample format, evaluates patient performance, and adjusts task requirements, content, and difficulty through complex branching algorithms. Performance is stored on disk so that the program begins each new session with the activity that follows the last completed activity in the previous session.

We asked the following questions:

1. Can aphasic subjects learn to use a comprehensive multilevel computer treatment program with minimal assistance from a clinician?
2. Do aphasic subjects who use the treatment software show improvement on standardized and nonstandardized language tests?
3. Do aphasic subjects who receive computer reading treatment improve more than aphasic subjects who receive nonlanguage computer stimulation and aphasic subjects who receive no treatment?

METHOD

Twenty-two aphasic adults participated for at least 3 months in the study. Each suffered a single, occlusive, left-hemisphere CVA resulting in aphasia of at least 1 year's duration. All subjects were premorbidly right-handed, were literate in English, and had completed at least the eighth grade. None had a history of premorbid psychiatric, reading, or writing problems. Subjects did not receive any other speech and language therapy during their participation in the study.

Three measures were administered to all subjects prior to and following a 13-week, 39-hour treatment trial: the Porch Index of Communicative Ability (PICA) (Porch, 1981), the Aphasia Quotient section of the Western Aphasia Battery (WAB) (Kertesz, 1982), and our own test composed of 232 items from the computer reading program, called the Comprehensive Communication Aphasia Test (CCAT). Measures were scored by two speech-language pathologists, one of whom had no knowledge of subjects' treatment group assignment.

Each subject was assigned randomly to one of three groups: computer reading treatment, computer stimulation, or no treatment. The groups were essentially the same in age, time after onset, years of education, and years spent in speech therapy (Table 23-1). The computer reading treatment group used computers 3 hours each week to run visual-matching and reading comprehension software. The computer-stimulation group used computers 3 hours each week to run cognitive rehabilitation software and computerized arcade-type games that did not include language stimuli. The no-treatment group received no computer reading treatment or stimulation, but they were evaluated at the beginning and end of the 13-week treatment trial.

The reading treatment software comprised 29 activities, each contain-

TABLE 23-1. DESCRIPTIVE DATA FOR SUBJECTS IN EACH GROUP

	Groups								
	Computer reading treatment (N = 10)			*Computer stimulation (N = 7)*			*No treatment (N = 5)*		
Variables	$\bar{X}$	RANGE	SD	$\bar{X}$	RANGE	SD	$\bar{X}$	RANGE	SD
Age (yrs.)	61.10	53–74	6.7	66.86	60–74	5.3	60.40	53–66	5.0
Time post onset (yrs.)	5.45	2–18	4.5	3.43	2.3–6	1.4	5.35	1.8–9	3.0
Education (yrs.)	13.90	8–18	2.5	16.00	12–20	2.9	14.90	13–18	2.1
Speech treatment (yrs.)	2.53	0.5–6.5	1.4	2.06	0.3–5	1.4	3.81	1–7	2.7
Sex	9 men, 1 woman			7 men			5 men		

MATCHING	COMPREHENSION
Letters	Match Upper & Lower Case Letters
single	Word
pair	function
three	category
Numbers	synonym
single	antonym
pair	spelling
three	Phrase
Mixed Letters and Numbers	function
pair	definition
three	spelling
Words	grammar
short	Question
long	who/what
	what/where
	where/when
	when/why
	why/who
	who/what/where
	when/why/what
	all question words
	Complex Reading
	yes/no questions
	orientation
	attributes/comparisons
	logic

Fig. 23-1. List of computer treatment tasks.

ing 8 levels of difficulty, totaling 232 different tasks (Fig. 23-1). The first 10 activities—the first 80 tasks—were perceptual visual-matching activities. The remaining 19 activities—152 tasks—required reading comprehension. The treatment software displayed only text and contained no pictures. Stimuli consisted of letters, numbers, words, phrases, and sentences. Task structure and response requirements were consistent from task to task and utilized a standard match-to-sample format that displayed two to five response choices. Subjects responded by pressing a single key on the keyboard, labeled 1 through 5, that corresponded to the selected response choices displayed on the screen. Tasks were arranged sequentially by assumed difficulty, which was determined by content and the number and types of foils. Movement within the treatment hierarchy was controlled automatically by the program, which measured accuracy of performance on baseline and generalization sets.

TABLE 23-2. NUMBER OF COMPUTERIZED TREATMENT ACTIVITIES AND TASKS COMPLETED AFTER 13 WEEKS FOR SUBJECTS IN THE COMPUTER READING TREATMENT GROUP

Treatment subjects	*Activities (max = 29)*	*Description*	*Tasks (max = 232)*
T-1	14	Words—synonyms	112
T-2	12	Words—functions	93
T-3	20	Phrases—grammar	153
T-4	12	Words—functions	91
T-5	12	Words—functions	89
T-6	14	Words—synonyms	108
T-7	15	Words—antonyms	120
T-8	12	Words—functions	92
T-9	18	Phrases—definitions	140
T-10	11	Upper/lowercase	82
Mean	14.0		108.0

Computer software used in the computer-stimulation condition was a combination of cognitive rehabilitation software and computer games that used movement, shape, and/or color to focus on reaction time, attention span, memory, and other skills that did not overtly require language or other communication abilities. While it seems likely that cognitive and recreational software require some level of language processing (e.g., labeling and planning responses), any language stimulation provided was unstructured and incidental and thus essentially different from the focused and intentional language activities of the reading treatment software.

RESULTS

Data relevant to the first question, whether aphasic subjects could learn to use a multilevel computer treatment program with minimal assistance from a clinician, are summarized in Table 23-2. All 10 subjects in the computer reading treatment group learned to use the software with minimal assistance from the clinician within three sessions. The mean number of activities completed was 108. The least number of activities completed was 82, and the most completed was 153.

TABLE 23-3. PRETREATMENT, POST-TREATMENT, AND CHANGE IN PERFORMANCE FOR SUBJECTS IN THE COMPUTER READING TREATMENT GROUP (N = 10)

	Pretreatment			*Post-Treatment*			
Measures	$\bar{x}$	RANGE	SD	$\bar{x}$	RANGE	SD	***Change***
PICA:							
OA (percentile)	54.1	22–77	16.8	58.5	29–82	18.2	+4.4
Rdg. (percentile)	57.1	17–76	19.9	63.5	21–93	23.4	+6.4
Vrb. (percentile)	53.6	27–73	14.1	55.7	31–78	14.8	+2.1
WAB AQ	73.7	42.6–92.3	14.7	75.3	51.1–92.8	13.2	+1.6
CCAT (max = 232)	180.8	126–217	29.8	184.9	145–214	22.4	+4.1

The second question, whether computer performance in the computer reading treatment group generalized to performance on noncomputerized measures, is answered by examining changes on the pretreatment and post-treatment tests (Table 23-3). Group mean for the PICA reading modality changed +6.4 percentile units. Group mean change was +4.4 units for the overall and +2.1 units for the verbal modalities. The aphasia quotient section of the WAB changed by +1.6 points, and the CCAT group mean changed by +4.1 points.

The third question, whether computer reading treatment results in more improvement than computer stimulation or no treatment, is addressed by data summarized in Tables 23-4 and 23-5. Pretreatment performance of each group is shown in Table 23-4. The groups showed a range of performance on the three measures. Group changes between pretreatment and post-treatment measurements are summarized in Table 23-5. The computer reading treatment group made more improvement during 13 weeks of treatment than the computer-stimulation group and the no-treatment group on the PICA reading modality score and the CCAT. The computer-stimulation group made more improvement on the PICA overall and verbal modality scores than the computer reading treatment group, which made more improvement than the no-treatment group. All groups displayed essentially no change on the aphasia quotient section of the WAB. The no-treatment group showed little change on all language measures.

CONCLUSIONS AND DISCUSSION

We attempted to eliminate several problems inherent in previous computer treatment studies, and we sought answers to some of the questions clinicians must ask regarding the efficacy of computerized treatment for aphasia. First, our results indicate that aphasic subjects can learn to use a comprehensive multilevel computer reading treatment program with minimal assistance from a clinician. All subjects in the computer reading treatment group moved up the hierarchy and completed an average of 108 tasks in 13 weeks of treatment. Second, improved performance on the computer reading tasks appeared to generalize to performance on noncomputerized measures, including improvement on the PICA overall, reading, and verbal modalities and the CCAT. Third, mean improvement on the PICA reading modality scores and the CCAT was greater for the computer reading treatment group than for the computer-stimulation group and the no-treatment group. PICA overall and verbal modality scores improved for both the com-

TABLE 23-4. PRETREATMENT PERFORMANCE FOR SUBJECTS IN THREE TREATMENT GROUPS

Measures	*Treatment (N = 10)*			*Stimulation (N = 7)*			*No treatment (N = 5)*		
	$\bar{X}$	RANGE	SD	$\bar{X}$	RANGE	SD	$\bar{X}$	RANGE	SD
PICA:									
OA (percentile)	54.1	22–77	16.8	49.0	28–79	18.8	53.0	34–66	12.2
Rdg. (percentile)	54.9	17–75	18.1	53.7	26–89	19.4	62.8	27–82	21.4
Vrb. (percentile)	53.6	27–73	14.1	47.4	16–81	20.8	51.2	41–63	8.5
WAB AQ	73.7	42.6–92.3	14.7	63.4	32.6–92.8	24.9	72.6	53.8–89.8	14.2
CCAT (max = 232)	180.8	126–217	29.8	191.0	161–227	24.2	197.0	145–215	29.2

TABLE 23-5. CHANGES ON LANGUAGE MEASUREMENTS FOR EACH GROUP

Measures	*Computer reading treatment (N = 10)*			*Computer stimulation (N = 7)*			*No treatment (N = 5)*		
	$\bar{X}$	RANGE	SD	$\bar{X}$	RANGE	SD	$\bar{X}$	RANGE	SD
PICA:									
OA (percentile)	+4.4	−2 to +11	3.5	+5.4	0 to +9	4.0	−0.4	−3 to +3	2.4
Rdg. (percentile)	+6.4	+3 to +13	3.3	+3.6	0 to +17	8.1	+1.6	−7 to +8	6.1
Vrb. (percentile)	+2.1	−3 to +7	4.2	+4.7	+3 to +15	5.9	−0.2	−4 to +5	3.3
WAB AQ	+1.6	−1.1 to +8.5	3.2	+1.0	+0.3 to +2.5	1.0	−1.4	−4.5 to +1.8	2.3
CCAT	+4.1	−10 to +19	11.0	−2.9	−11 to +8	7.8	+0.2	−9 to +4	5.4

puter reading treatment and computer-stimulation groups but not for the no-treatment group.

The computer-stimulation group showed the most improvement in the verbal modality section of the PICA — more than the computer reading treatment group, which showed more improvement than the no-treatment group. The reasons for this are not apparent. It could be, as Lynch (1983), Malec et al. (1984), and Enderby (1986) have speculated, that computer stimulation benefits not only cognitive abilities, but also communicative performance in chronic brain-damaged adults. This hypothesis would be supported if improved language scores persist in the computer-stimulation group when sample sizes in all groups are increased.

These preliminary results add to the growing literature on computerized treatment for aphasia. The implications are that computerized language treatment can be administered with minimal assistance by a clinician, that improvement on the computerized reading treatment tasks generalizes to improvement in non-computer-language performance, that improvement results from the specific language content of the software and not simply the stimulation provided by the computer, and that chronic aphasic patients can improve performance through computerized treatment. All implications, of course, require confirmation by a larger sample size, increased duration of treatment, additional language testing, and the application of statistical tests. These concerns and others, such as the efficacy of computerized writing treatment and the effect of the order of computer conditions on performance, are incorporated into the current project.

ACKNOWLEDGMENT

This project was supported in part by the U.S. Department of Veterans Affairs Rehabilitation Research and Development, Department of Medicine and Surgery.

REFERENCES

Enderby, P. (1986). Microcomputers in assessment, rehabilitation and recreation. *Aphasiology, 1,* 151–156.

Lynch, W. J. (1983). Cognitive retraining using microcomputer games and commercially available software. *Cognitive Rehabilitation, 1,* 19–22.

Malec, J., Jones, R., Rao, N., and Stubbs, K. (1984). Video game practice effects on sustained attention in patients with craniocerebral trauma. *Cognitive Rehabilitation, 2,* 18–23.

Katz, R. C., and Nagy, V. T. (1985). A self-modifying computerized reading program for severely-impaired aphasic adults. In R. H. Brookshire (Ed.), *Clinical aphasiology,* Vol. 15 (pp. 184–188). Minneapolis, MN: BRK Publishers.

Kertesz, A. (1982). *Western aphasia battery.* New York: Grune & Stratton.

Porch, B. E. (1981). *Porch index of communicative ability,* Vol. 2: *Administration, scoring and interpretation,* 3d Ed. Palo Alto, CA: Consulting Psychologists Press.