Microaphasiology and the Computerized Clinician

Richard C. Katz and Robert T. Wertz

There are many opinions about the application of microcomputers in aphasia rehabilitation. Motivations are clear: patients want to get better, families want to see the patients working toward recovery, clinicians are looking for new tools to expand their repertoire of clinical techniques, administrators want things to run efficiently, manufacturers want to sell computer systems, computer programmers want to sell disks, and researchers are always looking for something new to study. The truth of the matter is there isn't that much to talk about. Vaporware is the rage. Vaporware refers to a software product that is advertised, talked, and written about; evaluated in a prerelease review; purchased perhaps through the mail; and never used because it is not available—yet.

The lack of substantive treatment software can be the result of numerous wrong turns, but the fundamental problem is the adaptation of a flexible process (i.e., therapy) to a rigid medium (i.e., computer programming). It is easy to think of repetitive tasks that "would be good on the computer for aphasic patients," but developing treatment software is more than identifying and sequencing task components and coordinating the steps into a computer language.

Aphasiologists do not expect treatment software to be effective just because it is based on clinician-provided efficacious treatment (Loverso, Prescott, Selinger, Wheeler, & Smith, 1985). The introduction of microcomputers to the clinical environment has renewed recognition of treatment as a multifaceted behavioral exchange. Clinicians cannot anticipate all possible patient behaviors, and programmers can code only a limited number of contingencies. Referring to this problem, Odor (1988) wrote that computer-assisted learning defers decisions to programmers who are not physically present during the session but who must collect and send information through the computer medium, plan in advance how to handle the learning interaction, and then code these steps into a computer program. Odor concluded that computer-assisted instruction is more often based on convergent than divergent theories of learning. Most computer treatment studies in aphasia literature describe convergent activities, particularly drills in which specific responses are learned. When weighing the clinical value of microcomputers, it must be remembered that drills are only a small portion of aphasia treatment and clinicians must not be guilty of studying only the convenient aspects of aphasic behavior, that is, microaphasiology.

Aphasia treatment is defined as the systematic application of conditions designed to improve language ability and communication competence. Treatment can maximize the patient's ability to use language and, if necessary, help the patient communicate by using alternative methods. Some researchers, like Robertson (1990), have argued that the research evidence is not yet available to support the use of computers for the majority of language and cognitive problems. Robertson wrote that computers have been prematurely promoted in clinical work and their routine clinical use may be doing more harm than good.

Perhaps due to the impressive scope of his report on computer utilization in language and cognitive therapy, Robertson (1990) provided only a cursory review of most aphasia articles, and while the information he shared supports his conclusions, the information omitted is just as revealing. Robertson ignored specifics that are essential to intervention, paying little or no attention to the essential subject characteristics (e.g., age, education, source of subjects, gender, site of lesion, handedness, etiology, time post onset, severity of aphasia, type of aphasia) described by Brookshire (1983). He accused some researchers of misinterpreting Darley's (1972) restatement of the question, "Does therapy work?" by substituting more specific questions—What works with whom and under what conditions?—and obscuring the basic issue of whether anything works with anyone under any circumstances.

Robertson (1990) speaks for a number of researchers from practically every discipline who write that patients should be treated only when the process is proven efficacious. There is no substitute for carefully controlled, randomized studies, the documentation of which is the scientific foundation of the profession. Holland (1970) said it well when she wrote that the scientific community has a right to ask for our data, not our word. Most aphasiologists agree with this approach—without controlled studies there would be no science of aphasiology. However, clinicians point out that some critics of treatment software are vague as to what are the criteria for efficacious treatment, and it is unclear what constitutes adequate evidence. Criteria can be prescribed that might never be achieved. Those who have struggled to quantify and document the effect of treatment have an appreciation for the complexity of this and other questions concerning efficacy. Responsible clinicians are not blindly following a simple, step-by-step plan when providing treatment. Clinicians base intervention on theory and experience, and they routinely measure patient response as a guide to maximize treatment's effect. By measuring and documenting performance, each clinician begins to learn what works and what doesn't work for different patients. If a treatment works, it is continued; if it doesn't work, something else is tried. This is an acceptable approach in most professions providing treatment to patients. For example, the effectiveness of aspirin for headaches has never been tested in a controlled study, but physicians continue to prescribe it. Medical textbooks (e.g., Geiringer, Kincaid & Rechtien, 1988) recommend trial use of cervical traction to relieve neck pain even though it has never been tested, there is no medical basis for it, and some patients report an increase in pain, in which case the physician stops the treatment and tries something else.

These points emphasize the need for controlled, randomized studies to assess the potential efficacy of computer-provided treatment. Although an increasing number of computer studies are reported in aphasia literature, four major problems plague these reports. First, most aphasic subjects who received computer treatment were also participating in concurrent, traditional, clinician-provided speech treatment, the influences of which cannot be easily separated from the experimental effect. Second, no computer study has used a randomly assigned no-treatment control group for comparison with the treatment group. Most no-treatment groups reported in literature are self-selected, not randomized (Rosenbek, LaPointe, & Wertz, 1989). Third, the effects of structured, computerized language treatment have not been compared with the contribution of general, nonspecific stimulation provided by frequent use of the computer. Fourth, automated, multilevel treatment software which fully utilizes the advantages offered by microcomputers, without frequent monitoring and intervention by clinicians, has not been tested with aphasic patients.

An investigation was conducted in response to these problems, and a preliminary report was presented at the Clinical Aphasiology Conference in 1989 (Katz, Wertz, Lewis, Esparza, & Goldojarb, 1991). The purpose of the investigation was to create and evaluate the effectiveness of an automated, comprehensive computer program for providing hierarchically arranged reading treatment activities to chronic aphasic patients. The program presents reading activities in standard, match-to-sample formats; evaluates patient performance; and adjusts task requirements, content, and difficulty through complex branching algorithms. Performance is stored on disk, permitting the program to begin each new session at the point where the previous session ended. An editing program allows the clinician to create and modify sets of stimuli for testing and treatment and to monitor performance.

We asked the following questions: (1) Can aphasic subjects learn to use a comprehensive, multi-level, computer reading treatment program with minimal assistance from a clinician? (2) Do aphasic subjects using the computer reading treatment program improve on standardized and nonstandardized language tests? and (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

Currently, 43 subjects have participated in the Computer Reading Treatment, Computer Stimulation, and No Treatment groups. Each subject suffered a single, thromboembolic, left-hemisphere cerebrovascular accident (CVA) resulting in aphasia of at least one year's duration. Subjects scored between the 10th and 86th percentile on the Porch Index of Communicative Ability (PICA) (Porch, 1981) and displayed language deficits on the PICA and Western Aphasia Battery (WAB) (Kertesz, 1982) that were consistent with a diagnosis of aphasia. Premorbidly, subjects were right-handed and literate in English. Visual acuity was no worse than 20/100 corrected in the better eye and speech reception thresholds were no worse than a 40dB HL unaided in the better ear. Subjects were outpatients (i.e., not hospitalized during their participation in the study). An analysis of variance did not reveal significant differences among the three groups on initial PICA, WAB, and other test scores. In an effort to isolate and evaluate the effect of the computer program, subjects were discontinued from treatment and did not receive any additional speech or language therapy during their six-month participation in the study.

The following measures were administered to all subjects three times (at baseline or pretreatment, at three months or midtreatment, and at six months or posttreatment); the Porch Index of Communicative Ability (PICA); the Aphasia Quotient section of the Western Aphasia Battery (WAB AQ); and the researchers' own paper-and-pencil test, referred to as the C-CAT, composed of 232 items selected from the computer reading program. Analyses were performed to determine test-retest reliability on two administrations of the C-CAT for 15 non-brain-damaged adults and 15 aphasic adults. Correlation coefficients between test and retest performance were .97 and .96 respectively ($p < .0001$). The subjects' t tests showed no significant difference within each group between the two test administrations. PICAs were scored by two speech-language pathologists, one of whom had no knowledge of the subjects' treatment group assignments.

Each subject was assigned randomly to one of three groups: Computer Reading Treatment (referred to as the Treatment group), Computer Stimulation (referred to as the Stimulation group), or No Treatment. Table 1 summarizes the age, time postonset, years of education, and years of

TABLE 1. DESCRIPTION OF 43 SUBJECTS IN THREE GROUPS

	Treatment (N = 13)	*Stimulation* (N = 15)	*No Treatment* (N = 15)
Age (Yrs.)			
Mean	59.53	65.64	60.24
Range	51–69	59–74	49–72
SD	6.07	4.52	6.65
Time Post Onset (Yrs.)			
Mean	6.82	3.77	6.44
Range	2.0–19	2.1–9	1.8–18
SD	5.47	1.88	4.54
Education (Yrs.)			
Mean	13.73	14.96	13.88
Range	8.0–18	12–20	8.0–19
SD	2.37	2.53	2.68
Amount of Speech-Language Therapy (Yrs.)			
Mean	3.88	2.20	2.59
Range	0.5–19	0.3–7	0.3–7
SD	4.91	1.83	2.25

TABLE 2. MEAN (AND SD) LANGUAGE SCORES FOR ALL THREE EXPERIMENTAL GROUPS ($N = 43$)

	Treatment (N = 13)	*Stimulation* (N = 15)	*No Treatment* (N = 15)
PICA			
Overall %ile	60.00	55.73	63.33
	(14.14)	(20.24)	(15.83)
Reading %ile	61.83	61.40	69.73
	(18.99)	(19.43)	(19.19)
Writing %ile	60.69	58.40	61.33
	(22.29)	(23.64)	(22.84)
Verbal %ile	56.62	51.47	60.27
	(12.72)	(25.03)	(14.39)
WAB AQ	73.02	64.98	77.96
	(21.30)	(27.07)	(18.24)
C-CAT	189.54	192.13	196.73
	(23.46)	(24.01)	(29.30)

speech-language treatment for the 43 subjects in each of the three subject groups. Table 2 presents language test performance for all 43 subjects in each of the three subject groups. Analyses of variance did not reveal significant differences among the three groups for these measures.

Matching

Letters
- single
- pair
- set of three

Numbers
- single
- pair
- set of three

Mixed Letters and Numbers
- pair
- set of three

Words
- short
- long

Comprehension

Match Uppercase/Lowercase Letters

Words
- function
- category
- synonym
- antonym
- spelling

Phrases
- function
- definition
- spelling
- grammar

Questions
- 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/comparison
- logic

Figure 1. Computerized reading treatment task hierarchy.

In group one (Treatment), subjects used computers three hours each week to run visual-matching and reading-comprehension software. In group two (Stimulation), subjects used computers three hours each week to run cognitive-rehabilitation software and computerized, arcade-style games that did not include language stimuli. Each subject in these two groups accumulated 78 hours of computer use. In group three (No Treatment), subjects received no computer treatment or stimulation, but they were evaluated at entry in the study and at three and at six months later.

The reading-treatment software consisted of 29 activities, each containing eight different levels of difficulty, totaling 232 different tasks (Figure 1). The first 10 activities (i.e., 80 tasks) were perceptual, visual-matching activities. The remaining 19 activities (i.e., 152 tasks) required reading-comprehension skills. Reading-treatment software displayed only text: 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 multiple-choice items. Subjects responded by pressing a single key on the keyboard that corresponded to the selected multiple-choice item displayed on the screen. Tasks were arranged sequentially by assumed difficulty determined by content and the number and type of multiple-choice foils. Feedback consisted of response accuracy for each 10-item treatment set. No feedback was provided for the baseline or generalization sets. Criterion for each task was 80% accuracy or better over 3 consecutive trials on the initial 20-item baseline set and on the 10-item generalization set. Movement up and down the hierarchy was controlled automatically by the program which measured and responded to accuracy of performance on baseline and generalization sets.

Software used in the 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 is likely that cognitive and recreational software require some level of language processing, such as labeling and planning, any subsequent language stimulation is unstructured and incidental, and thus essentially different from the focused and intentional language activities of the computer reading treatment software.

RESULTS

All 13 subjects in the Treatment group learned to use the software within three sessions with minimal assistance from the clinician. The mean number of tasks completed by the subjects in the Treatment group after 6 months was 146. The least number of tasks completed was 88 ("identifying the function of words") and one subject completed all 232 tasks within the hierarchy, finishing with "object description."

Computer performance in the Treatment group appeared to generalize to performance on noncomputerized measures, as indicated by significant changes ($p < .05$) on the pre-, three-month mid-, and six-month posttests. Table 3 presents the mean and standard deviation values for pre-, mid- and postlanguage measures for the computer reading treatment group. The greatest change for the PICA Overall, Reading, Writing, and Verbal modalities and for the WAB AQ occurred between pre- and posttest performance. Significant improvement on the PICA Overall and Verbal modalities also occurred during the first 3 months and the second 3 months. PICA Reading and Writing modalities improved significantly during the second 3 months, and the WAB AQ improved significantly during the first 3 months.

TABLE 3. MEAN (AND SD) LANGUAGE SCORES FOR COMPUTER READING TREATMENT GROUP ($N = 13$)

	Pretest	*Midtest*	*Posttest*
PICA			
Overall %ile	60.00 (14.14)	64.08 (15.32)	68.31 (16.49)
Reading %ile	61.85 (18.99)	65.38 (19.53)	71.69 (20.58)
Writing %ile	60.69 (22.29)	63.23 (24.11)	66.08 (23.72)
Verbal %ile	56.62 (12.72)	60.08 (14.64)	66.31 (17.32)
WAB AQ	73.02 (21.30)	74.87 (20.58)	75.01 (20.49)
C–CAT	189.54 (23.46)	190.54 (24.45)	190.46 (27.66)

TABLE 4. MEAN (AND SD) LANGUAGE SCORES FOR COMPUTER STIMULATION GROUP ($N = 15$)

	Pretest	*Midtest*	*Posttest*
PICA			
Overall %ile	55.73 (20.24)	57.20 (19.48)	57.53 (19.01)
Reading %ile	61.40 (19.43)	62.07 (19.78)	67.00 (20.74)
Writing %ile	58.40 (23.64)	59.07 (23.74)	56.60 (25.08)
Verbal %ile	51.47 (25.03)	52.67 (24.74)	51.93 (23.64)
WAB AQ	64.98 (27.07)	65.56 (26.36)	65.35 (26.58)
C–CAT	192.13 (24.01)	190.00 (26.12)	191.67 (25.83)

Conversely, changes in the Stimulation group (Table 4) on all measures over time were not statistically significant. This was also true for the No Treatment group (Table 5).

Analyses of variance among groups revealed the Treatment group made significantly more improvement on PICA Overall percentile scores than the Stimulation group (pre- to posttest [$F = 6.51$, $p < .01$]; mid- to post-

TABLE 5. MEAN (AND SD) LANGUAGE SCORES FOR NO TREATMENT GROUP ($N = 15$)

	Pretest	*Midtest*	*Posttest*
PICA			
Overall %ile	63.33	63.93	64.60
	(15.83)	(17.26)	(16.13)
Reading %ile	69.73	70.53	72.60
	(19.19)	(20.35)	(18.87)
Writing %ile	61.33	63.87	63.20
	(22.84)	(22.05)	(23.63)
Verbal %ile	60.27	61.67	61.87
	(14.39)	(16.03)	(14.14)
WAB AQ	77.96	77.81	77.55
	(18.24)	(16.69)	(16.98)
C–CAT	196.73	198.93	199.00
	(29.30)	(29.61)	(25.24)

test [$F = 3.90$, $p < .01$]) and no treatment group (pre- to posttest [$F = 7$, $p < .01$]; mid- to posttest [$F = 3.56$, $p < .05$]). There were no significant differences in improvement between the Stimulation and No Treatment groups. No significant changes occurred among groups on the PICA Reading modality percentile values.

The Treatment group improved significantly more than the Stimulation group on the PICA Verbal modality. For example, significant differences in PICA Verbal percentile values from pre- to posttest ($F = 9.2$, $p < .01$) and mid- to posttest ($F = 6.96$, $p < .01$) were demonstrated. In the verbal modality, the Treatment group improved significantly more than the No Treatment group. Improvement in the Stimulation and No Treatment groups did not differ. The Treatment group made significantly more improvement than the Stimulation group on the PICA Writing performance. Pre- to posttest differences in writing were $F < 7.18$ ($p < .05$) and $F = 5.31$ ($p < .05$), respectively. The Treatment group did not differ significantly from the No Treatment group in PICA Writing percentile values, and the Stimulation and No Treatment groups did not differ in Writing.

No significant difference in performance was observed among the 3 subject groups on the WAB AQ values. Additionally, differences in C-CAT values for the subject groups were nonsignificant statistically.

DISCUSSION

The results suggest that: (1) computerized reading treatment can be administered with minimal assistance from a clinician, (2) improvement on the computerized treatment tasks generalizes to improvement on noncomputer language performance, (3) improvement results from the specific language content of the software and not the stimulation provided by the computer, and (4) chronic aphasic patients can improve performance through computerized treatment.

Determining efficacy of language rehabilitation for aphasic people is complex, and cannot be answered with a simple yes or no (Darley, 1972). Determining the efficacy of computerized treatment is uniquely complex. Each use of the computer involves specifics particular to the software and the patient, and not simply the applicability of the computer medium in aphasia treatment. Controlled treatment studies, such as the one described here, should assist clinicians in developing, evaluating, and utilizing treatment software. Clinicians who utilize computer software in aphasia treatment are responsible for demonstrating the efficaciousness of the software with each patient they treat. Clinicians should do their jobs responsibly with and without computers.

ACKNOWLEDGMENT

The authors wish to acknowledge the assistance of Susan M. Lewis, MA, and Cami Esparza, MA. This project was supported by the U.S. Department of Veterans' Affairs Rehabilitation Research and Development Service, Department of Medicine and Surgery.

REFERENCES

Brookshire, R. H. (1983). Subject description and generality of results in experiments with aphasic adults. *Journal of Speech and Hearing Disorders, 48,* 342–346.

Darley, F. L. (1972). The efficacy of language rehabilitation in aphasia. *Journal of Speech and Hearing Research, 37,* 3–21.

Geiringer, S. R., Kincaid, C. B., & Rechtien, J. J. (1988). Traction, manipulation, and massage. In J. A. DeLisa, (Ed.), *Rehabilitation medicine: Principles and practice,* Philadelphia: J. B. Lippincott.

Holland, A. (1970). Case studies in aphasia rehabilitation using programmed instruction. *Journal of Speech and Hearing Disorders, 35,* 377–390.

Katz, R. C., Wertz, R. T., Lewis, S. M., Esparza, C., & Goldojarb, M. (1991). A comparison of computerized reading treatment, computer stimulation, and no treatment for aphasia. In T. E. Prescott, (Ed.), *Clinical Aphasiology: Volume 19* (pp. 243–254). Austin, TX: PRO-ED.

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

Loverso, F. L., Prescott, T. E., Selinger, M., Wheeler, K. M., & Smith, R. D. (1985). The application of microcomputers for the treatment of aphasic adults.

In R. H. Brookshire (Ed.), *Clinical Aphasiology: 1985 Conference Proceedings,* Vol. 15 (pp. 189–195) Minneapolis: BRK Publishers.

Odor, J. P. (1988). Student models in machine-mediated learning. *Journal of Mental Deficiency Research, 32,* 247–256.

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

Robertson, I. (1990). Does computerized cognitive rehabilitation work?: A review. *Aphasiology, 4,* 381–406.

Rosenbek, J. C., LaPointe, L. L., & Wertz, R. T. (1989). *Aphasia: A clinical approach.* Austin, TX: PRO-ED.