Handwritten vs Computer Responses on Porch Index of Communicative Ability Graphic Subtests

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Agraphias (writing impairments) are widely discussed in the literature. Virtually all aphasia diagnostic batteries include evaluations of patients' writing ability (Schuell, 1957; Porch, 1967; Goodglass and Kaplan, 1973; and Kertesz, 1982). Examination of writing concerns itself with the ability to select words, compose sentences, and spell appropriately. The mechanical execution of the written output is also considered in the evaluation process. Porch (1967) includes efficiency as an important aspect of scoring graphic responses. The mechanics of writing are scored even though they may not necessarily represent the actual language abilities of the patient. Therefore the patients' ability to communicate by writing is assessed not only in terms of level of function, but judgments are made about the integrity of the neuro-processing system, based on the written output.

Descriptions of writing impairments largely concern themselves with analyses of the linguistic process breakdown that is evident in the writing of aphasic patients. These include lexical substitutions, function word errors, structurally similar errors, and derivational errors (Beauvois and Derousne, 1981). Many of these studies attempt to establish relationships between types of errors and other language impairments, lesion localization, and information processing. Some authors place diagnostic importance on writing with the dominant hand in order to differentiate between left-sided agraphia and disconnection of the corpus callosum (Brown, Leader, and Blum, 1983).

Writing is a process whereby an image of the word is evoked in auditory memory, the word is conceptualized and formulated in graphemes, and the form of the word or letter is produced. Thus, written language is the output stage of a process of changes that are applied to the auditory language system. In cases of aphasia, writing impairment becomes a manifestation of the language impairment itself and the ability to transfer language to written expression. The difficulty in analyzing the written responses of aphasic patients is that one must believe that a peripheral output process genuinely represents higher-level functioning of the language system.

In addition, many aphasic patients suffer from hemiparesis or paralysis of the dominant hand and therefore are resistant to writing, or their writing with the nondominant hand is distorted or illegible. Hansen and McNeil (1986) examined differences between writing with the dominant and nondominant hands in normal geriatric individuals. These authors reported subjective but not statistically significant differences in the writing of each hand. They concluded that writing differences were not due to the hand used in writing. They also point out that the writing of normal individuals is not error free.

The implementation of microcomputers in the clinical setting not only allows efficacious treatment for the patient (Loverso, Prescott, and Selinger, 1985) but may be an excellent device for measuring the linguistic abilities of an aphasic subject represented graphically while eliminating or reducing

the mechanical problems. Using the microcomputer as the graphic output modality for aphasic subjects may also be a good indicator of improvement in language abilities following treatment.

The purpose of this study was to examine differences between Porch Index of Communicative Ability (PICA; Porch, 1967) Graphics scores on Subtests A through E using standard PICA graphics responses and responses generated on a microcomputer. We asked the following questions. 1) Does using the microcomputer as a means of generating graphic responses reduce the distortions present when responses are handwritten? 2) Does the computer response format adequately represent patients' abilities to conceptualize, formulate, and graphically produce prompt, efficient responses?

METHOD

Subjects were eight left-hemisphere-lesioned individuals whose ages ranged from 44 to 71 with a mean age of 56.83 (S.D. = 10.3). Each subject was premorbidly right-handed. Four used the dominant hand and four used the nondominant hand for handwritten responses. Two subjects typed with both hands, two with the dominant right hand only, and four typed with the nondominant left hand only.

Each subject received a standard administration of the PICA on one testing occasion and a computer graphic administration on a separate day. The two testing sessions were separated in time by no more than one month. Prior to administration of the test a microcomputer program was designed for the Apple IIe. This program simulates the PICA graphics subtests A, B, C, D, and E. Administration of the computer graphic version differed from the standard administration in that the score sheets appeared on the computer monitor and the subject responded via keyboard (with the letters visible on each key). Initial instruction or orientation to the computer involved pointing out the keyboard, the space key, the return and delete keys, and the space bar. The standard PICA items were lined up in standard form on the table to the left of the keyboard. The only scoring procedural difference was that of 13, scored when the subject erased duplicated letters that resulted from a key being pressed for too long a period of time. This was not considered a self-correction (score of "10") since the error was mechanical. Otherwise, standardinstructions and procedures were followed. PICA test F was not included in the computer procedure due to the limitations of our microcomputer for drawing.

RESULTS

The data from this investigation were interpreted in two ways. First, analyses of variance for repeated measures (ANOVA II) were used to examine possible differences in scores between the handwritten PICA graphics and the computer typed PICA graphics (Figure 1). There were no significant differences (DF = 1,15; F = 3.23, $p < .05$) between the handwritten portion and the computer portion on the five PICA subtests. The mean score for handwritten responses was 10.39 (SD = 2.79). The mean score for the computer responses was 11.99 (SD = 3.09).

Analyses of Variance for Repeated Measures (ANOVA II) were used to examine the differences in time on the two response methods. A significant difference (DF = 1,15; F = 6.69; $p < .05$) between the two responses indicated that the computer portion was slower than the pencil portion. The mean time for the computer portion was 45.37 minutes (SD = 26.45) and the mean time for the pencil portion was 27.13 minutes (SD = 21.75).

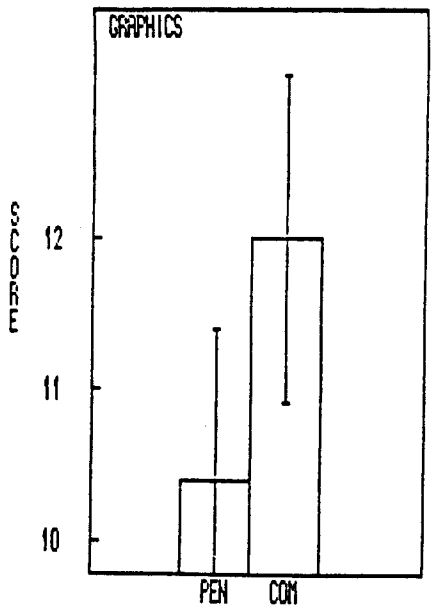

Figure 1. Handwritten (PEN) Graphics vs. Computer Time (COM).

Seven of eight of the left-hemisphere-damaged subjects produced computer responses that were slower than their pencil responses (Figure 2).

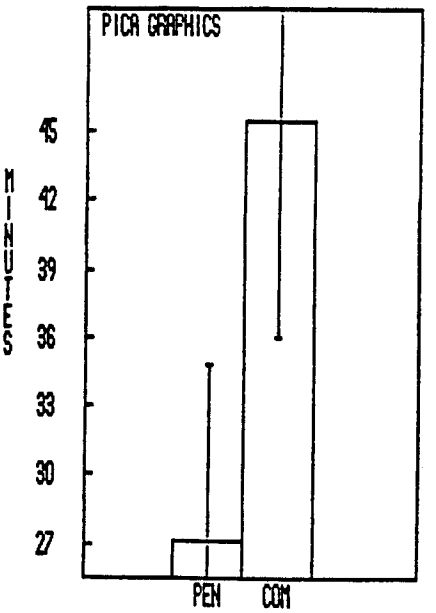

Figure 2. Handwritten (PEN) Graphics vs. Computer Scores (COM).

Preliminary data obtained for two subjects exhibiting bilateral lesions and for one subject exhibiting a right hemisphere lesion are presented in Table 1.

Table 1. Scores and time for completion of graphics subtests for two subjects with bilateral lesions and one subject with a right-hemisphere lesion.

Lesion Location	Score		Time	
	Handwritten	Computer	Handwritten	Computer
Bilateral	6.1	6.4	22	33
Bilateral	7.5	8.1	15	41
Right Hemisphere	9.1	7.8	15	14

CONCLUSIONS

Although there were visible differences in the two response types, graphic scores obtained from the computer and handwritten versions of PICA Subtests A-E indicated no significant differences. (See Appendix for samples.) This is similar to the results reported by Hansen and McNeil (1986) in the subjective evaluation of handwriting executed by each hand indicated different levels of legibility, but objective scoring procedures revealed no differences between the two.

In the current investigation the computer graphic portion eliminated scoring decisions in terms of legibility. A score of 14 or scores of boxed 4 and 7 were not needed as descriptions of mild to severe distortion producing errors (Porch, 1981). The computer graphics portion seemed to be easier to read and to score and yet the resulting mean scores were not significantly different. These findings suggest that either the computer responses or the written responses of the group reported here are represented equally by each method. Concern that the mechanics of writing tend to mask the actual language abilities of the subjects are not supported by these findings.

The finding that there was a statistically significant difference in time between the two methods of presentation indicates that although the actual output of the computer may be easier for the clinician to score it may not be the most efficient means of evaluating written language abilities. Using the computer as a type of prosthetic device involves other issues beyond clarity of production. First, the time needed to generate a response depends upon an individual's typing prowess in addition to their language difficulties. Second, individuals who use both hands to type are usually better typists than those who use the hunt and peck method. It is interesting to note, however, that the two subjects who typed with both hands followed the pattern of taking longer on the typing portion than the writing one. One subject repeatedly told me that she could write it but couldn't think of the words to type.

This finding raises the question whether or not a relationship exists between written language abilities and production by handwriting. Perhaps, once brain damage is incurred, it is easier to express written language in the manner that is learned initially. Additionally, it is possible that the process of typing intervenes between language abilities and writing and therefore we see increased amounts of time needed to complete the task. Loverso, Prescott, and Selinger, 1986, have reported that the same treatment program takes longer for aphasic patients to complete when it is presented via computer rather than with a clinician. It is possible that the increased treatment time via computer is due to the typing requirements of the program

APPENDIX: SAMPLES OF SUBJECTS' HANDWRITTEN AND COMPUTER RESPONSES

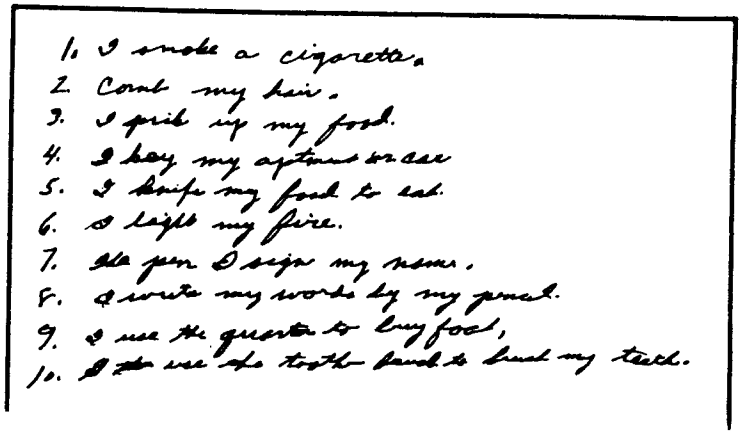

Figure 3. Sample of a subject's handwritten response on PICA Test A.

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=====|====|====|===|====|====|====|====|====|====|====|====
SUBTEST A
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A CIRGETTE YOU SMOKE .
A COMB YOU COMB YOUR HAIR .
A FORK IS UESD TO EAT WITH .
A KEY IS USED TO ONPEN THE DOOR .
A KNIFE IS USED TO CUT MAET .
MATCHES ARE UESD LIGHT FIRES .
A PEN IS UESD TO WRIGHT WITH .
A PINCEL IS USED TO WRIGHT WITH AND IS USED TO COCER WITH .
A QUARET IS USED TO BUY THING WITH .
A TOOTHBURSH IS USED TO BURSH YOUR TEETH WITH .
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Figure 4. Sample of a subject's computer typed response on PICA Test A.

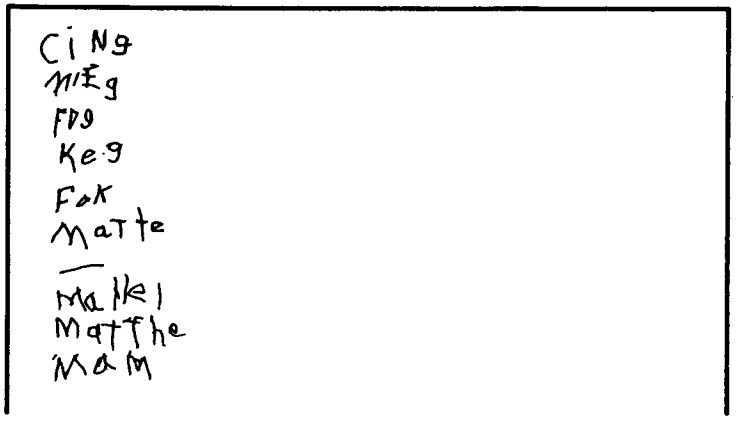

Figure 5. Sample of a subject's handwritten response on PICA Test B.

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=====|====|====|====|====|====|====|====|====|====|
SUBTEST B
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CIGRETTA
COMB
FORK
KEY
KNIFE
MATCHES
PEN
PENCIL
QUERTA
TOOTHBRUSH
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Figure 6. Sample of a subject's computer typed response on PICA Test B.

rather than the efficiency or human factor of the clinician. In other words, the computer may reduce handwriting problems while creating additional processing problems of its own.

The results of this investigation seem to indicate that prosthetic devices may not be efficacious in treatment when used as a means to intervene in the written language process. At the very least, we might state that computer graphic output may be equated with the handwritten output of the patient and that perhaps the best mode is the one most comfortable for the individual.

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DISCUSSION

Q: Would you be cautious in using this approach with a right hemisphere patient especially because of diagnostic information you might lose in terms of visual-spatial organization on a piece of paper? Is there some way that you could allow the patient to choose where he wants to start on the monitor to see if you can get at that visual-spatial component?

A: Sure, the only limitation with starting where they want to on the monitor instead of the page would be if I chose to have them type their first letter where I put the cursor versus them putting it wherever they wanted. After that they would have the freedom to do that. What this has told me is that what we're doing with the pencil is fine and we can leave it that way unless we run across a patient that really seems to need that kind of clarity. I had one patient who came into the hospital in a generally weakened condition and his handwriting was weak as well. When he typed his scores were better. In a case like this I could get a clearer sense of what he can do if he types, but on the whole I think I would leave it the way we've always had it, at least until I can study it further.

Q: Would you expect to find many differences in people who are really good typists?

A: I think its possible, but I had two patients exhibiting aphasia who were good typiests. They didn't type at extraordinary speeds, but they still followed the same pattern as the others. You might find more differences if you were asking them to type longer texts. Then individuals who were really good typists could produce a page much better when no differences occur for something shorter.