Computer-Assisted Anomia Treatment for Persons with Chronic Aphasia: Generalization to Untrained Words

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Purpose: This study sought to determine the effects of, and satisfaction with, intensive computer-assisted treatment for anomia using commercially available software with persons who have chronic aphasia.
Method: Six participants with chronic aphasia used eight Parrot Software programs in an intensive 32-hour treatment protocol lasting 4 weeks. The study measured the effect of this treatment on generalization of word finding abilities during confrontational naming and oral discourse. Participants' satisfaction with this treatment program was also measured.
Results: A significant ($p < .05$) improvement in confrontation naming ability for non-trained words occurred following computer-assisted treatment. Additionally, message informativeness during oral discourse increased for four of the six participants. Participants felt that the treatment employed acceptable procedures and goals, and they expressed overall satisfaction with the intervention program.
Conclusions: Intensive use of certain commercially-available Parrot software programs may improve overall word finding abilities during confrontational naming tasks as well as oral discourse in persons with aphasia. This type of treatment may be a cost-effective supplement to traditional speech-language therapy for anomia.

Key Words: aphasia, anomia, word retrieval, word finding, computer-assisted treatment, aphasia treatment software

INTRODUCTION

One of the few connecting threads among the various subtypes of aphasia is difficulty in expressive word-finding, also known as anomia. Word retrieval problems are a significant factor in communication breakdown for persons with aphasia (PWA) and their conversation partners (e.g., Basso, 2003;

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Boyle, 2004; Lesser & Algar, 1995; Nickels, 2002; Ramsberger & Marie, 2007). Two theories that provide a basis for the treatment of anomia are rooted in the theoretical origins of anomia: semantic descriptions and phonological characteristics. The most effective treatment protocols for improving naming ability parallel the typical process of lexical activation and include semantic and phonological processing (Linebaugh, Shisler, & Lehner, 1977; Raymer & Rothi, 2002; Weidner & Jinks, 1983). Additionally, orthographic and phonological cues have been found to be equally effective in the trained retrieval of words (Herbert, Best, Hickin, Howard, & Osborne, 2001). Semantic, phonological, and/or orthographic cues can be provided by clinicians or other therapy instruments such as, in recent years, computers.

Traditional speech-language treatment often involves a stimulation approach, based on several general principles first outlined by Schuell, Jenkins, and Jimenez-Pabon (1964) and later expanded upon by Brookshire (1997). These general principles, as summarized by Coelho, Sinotte, and Duffy (2008), include the following: use of intensive, controlled, repetitive sensory stimulation (primarily auditory, although other modalities can be employed); elicitation of a maximum number of responses, provision of feedback regarding response accuracy; use of sequenced, systematic, and intensive treatment with varied and abundant materials, beginning with familiar, relatively easy tasks and ultimately extending to new materials and procedures. Many of these general treatment principles can be implemented with the assistance of computers.

This study sought to determine the effects of, and satisfaction with, intensive computer-assisted treatment for anomia using commercially-available software with persons who have chronic aphasia.

Computers in Treatment

Several studies have addressed the treatment of anomia with computerized therapy using various programs (Colby, Christinaz, Parkison, Graham, & Karpf, 1981; Doesborgh et al., 2004; Fink, Breecher, Schwartz, & Robey, 2002; Laganaro, Di Pietro, & Schnider, 2006; Ramsberger & Marie, 2007; Van Mourick & Van de Sandt-Koenderman, 1992). Improvement was noted on confrontational naming tasks for trained items in several studies; however, no data were collected to suggest generalization of word-finding abilities to untrained words. Raymer, Kohen, and Saffell (2006) observed generalization for "some untrained words" in one of the two participants who were trained 1 to 2 times per week. Two of five participants who were trained 4 to 5 times per week showed significant improvement in word-retrieval for untrained items. During follow-up testing, the ability of all participants to name pictures was above baseline levels.

One set of programs that has not yet been investigated was developed by Parrot Software, a company that markets treatment software for people with communication impairments (Parrot Software, 2009). Within this scope, Parrot Software has many specific software programs that are designed to address specific areas that may be problematic for PWA: cognitive reasoning, word recall, reading, vocabulary and grammar, memory and attention, and functional skills. Katz (2001) identified two specific Parrot Software programs that target word finding difficulties. These programs are Visual Confrontation Naming© and Verbal Picture Naming Plus©. No published data were found supporting or refuting Parrot Software's rationale for or efficacy of these two programs. Wertz and Katz (2004) stressed the need for additional efficacy studies regarding specific treatment software for PWA.

Colby et al. (1981) described a phenomenon of strategy generalization from the software program used to cue persons for word-retrieval to independent use of the strategies without the computer. PWA in Colby et al.'s study described using an internal cueing hierarchy, modeled from the computer program, to independently answer cue questions and find their own words. Other treatments for anomia have focused on this aspect and some have reported increased use of internal cues by PWA (Dede, Parris, & Waters, 2003). Based on these principles, using computer software programs to facilitate word retrieval, ultimately for nontrained/targeted words during confrontational naming tasks and oral discourse, is an area of research that merits further exploration.

Socially Valid Treatment

In addition to empirical data within a research study, social validation is an essential marker of how a treatment program is received by consumers. Social validation is defined as utilizing measures to assess the social acceptance of treatment goals, methods, and outcomes (Kazdin, 1977; Schlosser, 1999; Wolf, 1978). Although empirical data are objective measures of results, they only record part of the treatment effect. Participants' thoughts and views of treatment indicate not only personal satisfaction, but also have implications for usability and acceptability of treatment. Social validity contributes to the overall effect of a treatment program and is useful when identifying and supporting evidence-based practice (Schlosser, 2003). Thus, assessing the social validity of a treatment task helps ensure that participants approve of the treatment goals, methods, and outcomes.

Treatment Intensity

The intensity of traditional speech and language treatment in aphasia is a topic that has been widely investigated (e.g., Bhogal, Teasell, & Speechley, 2003; Poeck, Huber, & Willmes, 1989; Robey, 1998). According to Bhogal and colleagues (2003), a higher intensity therapy program implemented over a shorter period of time provides a significant result as compared to a therapy program that is less intense and implemented over a longer period of time. More specifically, of the eight studies reviewed, the four in which positive changes occurred during therapy included an average of 8.8 hours of therapy per week for 11.2 weeks. Conversely, the four studies in which negative or no change occurred included an average of 2 hours of therapy per week for 22.9 weeks. Similarly, Robey's (1998) meta-analysis of clinical outcomes in aphasia treatment revealed that ≥ 2 hours of treatment per week resulted in greater gains compared to < 2 hours per week. Thus, the intensity of treatment is an important factor to consider when evaluating the efficacy of a particular treatment program. One possible way to increase treatment intensity is through the use of personal, at-home computers.

Purpose of the Study

The primary objective of this study was to determine whether or not PWA improved their ability to find nontrained words during confrontation naming and oral discourse after using computer software programs intensively over a 4-week period. The secondary purpose of this study was to determine whether or not PWA were satisfied with the computerized form of intervention.

METHODS

Research Design

A one-group single-treatment counterbalanced design (also known as a crossover design; Hegde, 2003) was employed using six participants. The independent variable was the computer-assisted Parrot software treatment protocol. The dependent variables were: (1) word finding during confrontation naming tasks as measured by the Boston Naming Test and the Western Aphasia Battery Naming and Word Finding subtest and (2) word finding during an oral discourse picture description task as indicated by the number of correct information units conveyed. Additionally, participants completed a program evaluation inventory at the end of the study.

Participants

Participants included six PWA (four males, two females) with an age range of 42 to 66 years and mean age of 52 years. Five of the six individuals had left hemisphere lesions as documented by head computerized tomography (CT) and/or brain magnetic resonance imaging (MRI) scans. One left-handed individual had a right hemisphere lesion that resulted in conduction aphasia. All participants were at least 6 months postonset of stroke/aphasia, with a mean length of 37 months and a range of 11 to 85 months post onset. Demographic information for participants is reported in Table 1.

All of the participants had a history of individualized and/or group speech-language treatment poststroke; however, none were receiving any type of speech-language treatment at the time of the study. Inclusion criteria for participation included the ability to comprehend text, see the computer screen, hear stimuli through headphones (adjusted to each person's most comfortable listening level), and manipulate computer devices (i.e., keyboard, mouse, headphones, volume control).

Procedures and Measures

This 8-week study consisted of three testing sessions (Testing Session 1 [TS1], Testing Session 2 [TS2], and Testing Sessions 3 [TS3]) alternating with two periods of computerized treatment/no treatment. The six participants were divided into two subgroups of three persons each (Subgroup A, Subgroup B). Prior to the treatment period, the participants underwent an orientation regarding the operation of the computers based on an Internet training program from Egan and Worrall (2001).

During the treatment period, the PWA participated in four computerized treatment sessions per week for 4 weeks, with each session lasting 2 hours. Each participant wore headphones and was

TABLE 1. Participant Demographic Information

Information	Participant A1	Participant A2	Participant A3	Participant B4	Participant B5	Participant B6
Age	42	57	50	56	66	43
Gender	Male	Female	Male	Female	Male	Male
Ethnicity	Caucasian	Caucasian	Hispanic	Hispanic	Caucasian	Chinese
Education Level	High School	Post High School	High School	High School	Post High School	Post High School
Primary Language	English	English	English	English	English	Mandarin Chinese
Months Post-Stroke	18	85	25	27	11	58
Lesion Side	Left Hemisphere	Left Hemisphere	Left Hemisphere	Right Hemisphere	Left Hemisphere	Left Hemisphere
Premorbid Handedness	Right	Right	Right	Left	Right	Right
WAB Aphasia Quotient	79.2	75.3	69.3	82.7	76.4	79.7
Aphasia Type	Anomic Aphasia	Transcortical Motor Aphasia	Broca's Aphasia	Conduction Aphasia	Anomic Aphasia	Anomic Aphasia

positioned in front of either a laptop or a desktop computer. For the first 4 weeks, Subgroup A (three participants) received the computerized treatment (described further in the Equipment & Materials section) and Subgroup B (three participants) did not receive any treatment. At week 4, results from confrontation naming and picture description tasks were obtained for TS2 from all six participants. For the next 4 weeks, Subgroup B received the computerized treatment and Subgroup A did not receive any treatment. TS3 at 8 weeks included collecting data once again from confrontation naming and picture description tasks from all six participants.

TS1 served as a pretest or baseline condition and included administration of the complete WAB (Kertesz, 1982),which includes the Naming & Word Finding subtest (WAB-N&W), as well as measurements from the Boston Naming Test (BNT) (Goodglass & Kaplan, 2001) and a Norman Rockwell (Rockwell, 1958) picture description at week 0 from all participants. Approximately 84 single words were assessed during various confrontation naming tasks on the WAB N&W and the BNT, including four overlapping words (i.e., pencil, comb, toothbrush, and screwdriver). Words from these tests were not specifically trained/targeted during the treatment sessions; however, 17 commonly used words (e.g., paper clip, hammer, screwdriver, pencil) happened to be included in the 500+-word corpus of computerized treatment stimuli. Thus, these words were excluded from the testing results. TS2 and TS3 included the same measurements as TS1.

To assess word finding at the oral discourse level for the picture description task administered during TS1, TS2, and TS3, correct information units (Nicholas & Brookshire, 1993) were counted. PWA were asked to describe events in the Norman Rockwell painting entitled *The Runaway* (Rockwell, 1958). The Correct Information Unit (CIU) analysis involves a standardized scoring system developed by Nicholas and Brookshire (1993) as a means of quantifying the degree of efficiency and informativeness with which PWA convey information during connected speech/discourse. By increasing one's ability to retrieve words during connected speech, an increase in the informativeness (correct information units) of the discourse might be expected to follow. Although counting CIUs is not intended to be viewed as a direct measure of word finding during oral discourse, this method could serve to identify changes in message informativeness that positively affect functional communication in an oral discourse task.

The Program Evaluation Inventory-Short form (PEI-SF) was administered at the end of TS3 to determine if participants in the study believed that the treatment employed acceptable procedures, appropriate goals, and if they felt overall satisfaction with the intervention program. The PEI-SF is an adaptation of the Treatment Evaluation Inventory (TEI) (Kazdin, French, & Sherick, 1981) and the TEI-Short Form (TEI-SF) (Kelley, Heffer, Gresham, & Elliot, 1989). Some modifications were made to the PEI-SF in an attempt to better meet the needs of PWA, as follows: The PEI-SF involved a question-based item list as opposed to the statements utilized by the TEI and TEI-SF. Questions on the PEI-SF were worded to target PWA who participated in a treatment task, rather than the participants' caregivers or health professionals. Two items from the TEI-SF were eliminated because they specifically addressed the use of treatment procedures on children without consent and the effects on caregivers, neither of which were applicable in this study. The PEI-SF asked PWA to respond to each question using a vertical visual analog scale (VAS) rather than a numeric Likert scale. The VAS for the PEI-SF included a graphic representation of the verbal descriptors (strongly agree ☺; strongly disagree ☹) anchored at each end of a 100-millimeter (mm) line as is common for VAS (e.g., Collins, Moore, & McQuay, 1997). The response lines were rotated from a horizontal to a vertical position to better depict "high" and "low" opinions and decrease the possibility of participants not seeing the entire line due to visual field deficits. The PEI-SF instructed the PWA to rate their responses to each question by marking a dash on the vertical response line at the level/point of their choice. The PEI-SF was scored by measuring the distance from the bottom ("strongly disagree"; 0 mm) to the PWA's response mark.

Equipment

Each participant was assigned to one computer for all of the computerized treatment sessions. Participants A1 and B4 used a Dell Latitude XT laptop (Intel® Core™2 Solo CPU, U2100 @ 1.06 GHz, 788 MHz 896 MB of RAM) running Microsoft Windows XP Tablet PC Edition. Participants A2 and B5 used a Dell Inspiron laptop (Intel® Pentium® Dual Core T4200, 2.0 GHz/800 Mhz FSB/1 MB cache) running Microsoft Windows XP Professional Edition. Participants A3 and B6 used a Dell Optiplex GX520 desktop computer (Intel® Pentium® 4 CPU 3.20 GHz, 3.19 GHz, 0.99 GB of RAM) running Microsoft Windows XP Professional Edition. All participants used Koss TD-61 Stereophone headphones for all programs except Multisensory Words©. For the Multisensory Words© program, all participants used Logitech ClearChat Pro USB™ headphones that contained a headset microphone for recording. Each participant used an external USB mouse with two click buttons. The mouse was placed on the participants' preferred side (right or left), and the click buttons were adjusted accordingly.

Computer Software Programs Used in Treatment

For the purpose of this study, five primary and three supplemental software programs were chosen from Parrot software's descriptive categories of word finding, vocabulary, and cognitive reasoning. Program selection was based on ease of use, modality of input and output, and consistency with the general principles of a stimulation approach to treatment (Coelho, Sinotte, & Duffy, 2008). Table 2 shows various characteristics of each program used. Across all of the chosen software programs, over 500 different words were targeted. The following five primary programs were selected for use in this study: (a) Word Associations©, (b) Form and Function©, (c) Inferential Naming©, (d) Visual Confrontation Naming©, and (e) Sentence Completion©. Each software program was composed of multiple lessons. Because three of the primary programs were brief in duration, three supplemental programs were used to provide novel stimuli after the PWA had completed the primary programs twice. The Functions© program supplemented Word Associations©, Multisensory Words© supplemented Inferential Naming©, and Deductive Reasoning© supplemented Sentence Completion©.

During every 2-hour treatment session, five software programs (i.e., Word Associations© or Functions©, Form & Function©, Inferential Naming© or Multisensory Words©, Visual Confrontation Naming©, and Sentence Completion© or Deductive Reasoning©) were administered for 20 minutes, with a required 5-minute break between each program to change the programs on the computer, stretch, go to the restroom, and/or eat a snack. To avoid order effects, Parrot Software programs were randomized so that the sequence in which programs were presented varied across participants and across treatment sessions. Participants were instructed regarding the order in which to progress through their five assigned programs, and this order changed each day. However, the order of presentation of lessons

TABLE 2. Qualities of the Selected Parrot Software Programs Used for Intervention

Parrot Software	Description	Parrot Category	Stimuli Modality	Response Modality	Feedback	Cues Provided	Cuing Hierarchy
Word Associations©	The program presents a word and then asks the user to find an associated word in a list of words.	Vocabulary	Orthographic	Click Verbalization[a]	Yes	No	N/A
Functions©	Provided with written or spoken functions, users find the appropriate picture.	Vocabulary	Orthographic Auditory Visual	Click Verbalization[a]	Yes	No	N/A
Form and Function©	Users identify features of words, e.g., location, function, appearance, and color. Stimuli generated randomly. Users are asked questions: *Which ones are found in a hospital?* Users move words to list.	Cognitive Reasoning	Orthographic	Click Verbalization[a]	Yes	No	N/A
Inferential Naming©	Users determine the identity of a concealed word. Up to 7 additional semantic clues can be requested. The 8th clue is the first letter of the word and the 9th clue is the word presented in multiple-choice format. For each incorrect response, a new clue is provided.	Cognitive Reasoning	Orthographic Auditory	Type Answer Verbalization[a]	Yes	Yes, Specific Order	Category Function Location Size Shape/Color First Letter
Multisensory Words©	A picture is displayed and users cue themselves or they can record their own production of the word and can even play back that recording and a recording of the actual name.	Word Finding	Orthographic Auditory Visual	Type Answer Verbalization[a]	Yes	Yes, PWA Determines Order of Cue	First Letter Spelling List Own Production
Visual Confrontation Naming©	Users are asked to type the name of each picture. Program uses real-life pictures.	Word Finding	Orthographic Auditory Visual	Type Answer Verbalization[a]	Yes	Yes, PWA Determines Order of Cue	First Sound Description Sentence
Sentence Completion©	An open phrase is displayed at the top of the screen and the user must select the word that finishes the phrase from three choices listed.	Word Finding	Orthographic Auditory	[a]	Yes	No	N/A
Deductive Reasoning©	A set of rules is presented that describes a class of words. User determines if each item fits the rules.	Cognitive Reasoning	Orthographic	Click Verbalizationa	Yes	No	N/A

[a]Participants were encouraged to say target words aloud.

within each program was sequential and identical across all participants (i.e., lesson 1, lesson 2, lesson 3, etc.). After a participant completed a lesson sequence for a primary program two full times, the participant was instructed to switch to the supplemental program and begin the lesson sequence for that program. After the supplemental program's lesson sequence was completed two full times, the participant was instructed to switch back to the primary program and continue. This cycle repeated until the end of the 4 weeks of treatment. Some supplemental programs, such as Functions©, did not have associated "lessons" and were continued for the same amount of treatment time as was spent on the associated primary program. Table 3 provides an example of a schedule for one day of treatment.

Computer-Assisted Treatment Protocol

Each Parrot Software program contained on-screen instructions to which the PWA could refer at any time. In addition to on-screen instructions, the researcher instructed the PWA to attempt to verbally say the target words while completing the tasks. Typed cue cards reminding the PWA to speak out loud were posted on the computer frame (above the screen). The researcher also provided each participant with a typed card stating the program order/progression for each 2-hour treatment session. During the administration of the computer-assisted treatment for anomia, the researcher followed a series of hierarchical cues to facilitate completion of the tasks. These cues were only administered if the PWA requested clarification; the researcher did not independently initiate contact unless the PWA had difficulty completing a task due to computer operational issues or unclear program instructions. When the PWA requested clarification about computer operation or the operation of the program, the researcher followed a "computer trouble" cueing hierarchy (Appendix A). A separate "content" cueing hierarchy (Appendix B) was applied when the PWA requested clarification regarding the program contents or instructions. The researcher did not provide feedback regarding the accuracy of word finding or word production; PWA only received the feedback from the software programs indicating a correct or an incorrect response. This computer feedback was provided via auditory and visual modalities.

To ensure treatment fidelity, the researcher maintained a daily protocol check sheet and log regarding program order/progression, use of computer trouble cueing hierarchy, and use of content cueing hierarchy for each participant. A second researcher observed 25% of the treatment sessions

TABLE 3. An Example of Computer-Assisted Treatment Program Sequence for Three Participants on One Day

	Participant A1	**Participant A2**	**Participant A3**
1st Assignment	Form and Function© (P)	Visual Confrontation Naming© (P)	Sentence Completion© (P) Deductive Reasoning© (S)
5-minute break			
2nd assignment	Inferential Naming© (P) Multisensory Words© (S)	Sentence Completion© (P) Deductive Reasoning© (S)	Word Associations© (P) Functions© (S)
5-minute break			
3rd assignment	Visual Confrontation Naming© (P)	Word Associations© (P) Functions© (S)	Form and Function© (P)
5-minute break			
4th assignment	Sentence Completion© (P) Deductive Reasoning© (S)	Form and Function© (P)	Inferential Naming© (P) Multisensory Words© (S)
5-minute break			
5th assignment	Word Associations© (P) Functions© (S)	Inferential Naming© (P) Multisensory Words© (S)	Visual Confrontation Naming© (P)

(P): Primary program assignment; (S): Supplemental program assignment.

and maintained separate check sheets and logs. When compared, the protocol check sheets were in agreement 100% of the time. The cueing hierarchy logs were in agreement 98% of the time. In sum, the computer-assisted treatment program was implemented with high fidelity.

RESULTS

Because of the small number of participants, nonparametric distribution-free statistics were used. Data were analyzed as follows:

Order of Treatment

A Wilcoxon matched-pairs signed ranks test was used to rule out the presence of order effects, as the sequence of treatment/no treatment between the two subgroups was different. Table 4 presents TS1, TS2, and TS3 BNT and WAB N&W adjusted scores and subgroup mean scores. Results indicated that Subgroup A's performance was not significantly different ($p > .05$) from Subgroup B's performance across time. This indicates that order of treatment (i.e., whether a subgroup began with 4 weeks of treatment followed by 4 weeks of no treatment or began with 4 weeks of no treatment followed by 4 weeks of treatment) had no effect on the overall performance of participants.

Word Finding During Confrontation Naming Tasks

Results of the Boston Naming Test (BNT) for all participants are shown in Figure 1. A Wilcoxon matched-pairs signed ranks test showed that the difference between the mean score on the BNT for TS 1 (M = 25.33, SD = 6.77) and TS 3 (M = 34.17, SD = 7.139) was significant beyond the .05 level: asymptotic $p = .02$ (two-tailed). The sums of ranks were 0 and 21 for negative and positive ranks, respectively; therefore, W = 0. These results indicate that individual performances on the BNT for TS3 were significantly higher than performances on the BNT for TS1, indicating a treatment effect. This was further supported by a large effect size (d = 1.35). Additionally, the improvement in scores can be attributed to the treatment, as scores for Subgroup A increased from TS1 (M = 27) to TS2 (M = 31) and then remained somewhat stable following a 4-week no-treatment phase (M = 35). Subgroup B's scores remained stable from TS1 (M = 24) to TS2 (M = 24) during a period of no-treatment and then increased following the 4-week treatment period (M = 34).

Results of the WAB Naming & Word Finding subtest (WAB N&W) for all participants are depicted in Figure 2. A Wilcoxon matched-pairs signed ranks test showed that the difference between the mean score on the WAB N&W for TS 1 (M = 5.417, SD = .64) and TS 3 (M = 6.250, SD = .66) was sig-

TABLE 4. Results of Confrontation Naming and Word Finding Tests

	BNT*			WAB N&W*		
Participants	**TS1**	**TS2**	**TS3**	**TS1**	**TS2**	**TS3**
A1	29	39	40	5.9	6.5	6.5
A2	27	21	30	4.8	5.8	6.1
A3	24	32	34	5.1	6.2	5.6
Subgroup A Mean	27	31	35	5.3	6.2	6.1
B4	33	30	43	6.4	6.5	7.3
B5	26	28	35	4.8	4.4	5.5
B6	13	14	23	5.5	5.7	6.5
Subgroup B Mean	24	24	34	5.6	5.5	6.4

BNT = Boston Naming Test.

WAB N&W = Western Aphasia Battery Naming and Word Finding subtest.

*Adjusted scores: trained words excluded.

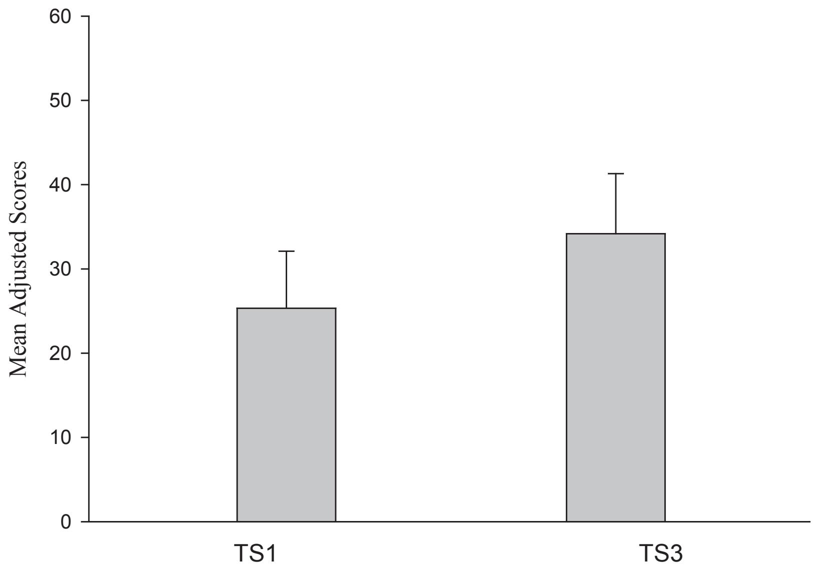

Figure 1. Mean adjusted scores on Boston Naming test across six participants for testing session 1 (TS1) and testing session 3 (TS3).

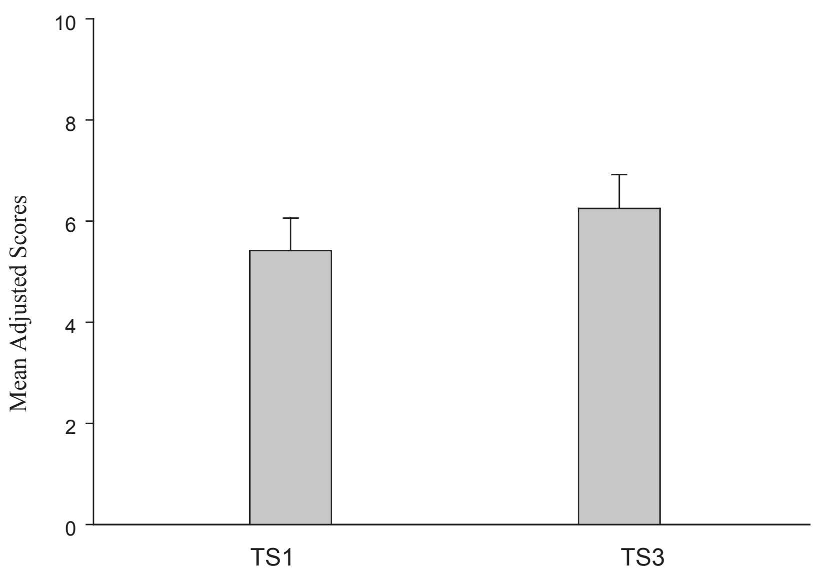

Figure 2. Mean adjusted scores on Western Aphasia Battery Naming and Word Finding Subtest across six participants for testing session 1 (TS1) and testing session 3 (TS3).

nificant beyond the .05 level: asymptotic p = .02 (two tailed). The sums of ranks were 0 and 21 for negative and positive ranks, respectively; therefore, W = 0. These results indicate that individual performances on the WAB N&W for TS3 were significantly higher than performances on the WAB N&W for TS1, indicating a large effect size (d = 1.28). Additionally, the improvement can be attributed to the treatment, as scores for Subgroup A increased from TS1 (M = 5.3) to TS2 (M = 6.2) and remained somewhat stable following a 4-week no-treatment phase (M = 6.1). Subgroup B's scores remained somewhat stable from TS1 (M = 5.6) to TS2 (M = 5.5) during a period of no-treatment and then increased following the 4-week treatment period (M = 6.4).

Word Finding During Oral Discourse

Although the WAB aphasia quotients for PWA in this study only ranged from 69.3 to 82.7, their performances on the picture description task varied substantially. For example, the total number of CIUs for TS1 on the Norman Rockwell Runaway picture description ranged from 4 in Participant A3 to 74 in Participant B4 (mean for group = 36.5; S.D. = 27.1). Due to the large individual variation in performance, statistical tests were not used to evaluate the group data. Rather, a graph depicting each participant's performance at TS1 compared to TS3 is provided in Figure 3.

Participants A1 and B3 used fewer CIUs at TS3 compared to TS1. Their total number of CIUs decreased by 12% and 14%, respectively. Participants A2, A3, B1, and B2 used more CIUs at TS3 compared to TS1. Their total number of CIUs increased by 45%, 69%, 65%, and 43%, respectively. Two examples of the changes/increases in oral discourse production are provided here. Participant A3's discourse at TS1 was follows: "Radio. A cop and um boy. Uh." When prompted by the researcher to share anything else he could about the picture, Participant A3 responded, "No. . . . uh can't." His transcript from TS3 was as follows: "Diner. Uh Man policeman and boy in a diner and uh cop. And uh uh running home—away from home—pie and radio. . . . coffee." In addition to adding six nouns, Participant A3 also used two prepositional phrases and one verb. His CIUs increased from 4 at TS1 to 13 at TS3. Participant B1's discourse at TS1 was as follows: "A guy is talking to the policeman. It is in a restaurant. He is trying to tell the policeman that he is alright because he is trying to run away. The salesman is trying to help him out, too." His transcript from TS3 was as follows:

The little boy was running away. He had a knapsack on the floor. He was trying to tell the policeman about it. There was/on the counter there was a radio a special today. The policeman was listening to him as well as the person at the counter. There was coffee, sugar, a coffee pot on the counter. He had a coat. There were four stools at the counter.

Participant B2 provided a more appropriate introductory sentence in the T3 transcript. He also provided more descriptive information about the picture. His CIUs increased from 39 at TS1 to 69 at TS3. In sum, 4 of the 6 participants' transcripts were characterized by an increased number of CIUs (i.e., increased message informativeness) after completing the computerized anomia treatment.

Program Satisfaction

The Program Evaluation Inventory-Short Form (PEI-SF) was administered to the participants after the intervention to determine if they believed that the program employed acceptable treatment procedures and goals and if they felt overall satisfaction with the intervention program. The data were analyzed using descriptive statistics. The mean data for participants across seven questions indicate that they were very satisfied with the intervention program. The mean scores across seven questions ranged from 78.4 to 91.9 on a 100 mm scale, with 100 representing "strongly agree" for statements of satis-

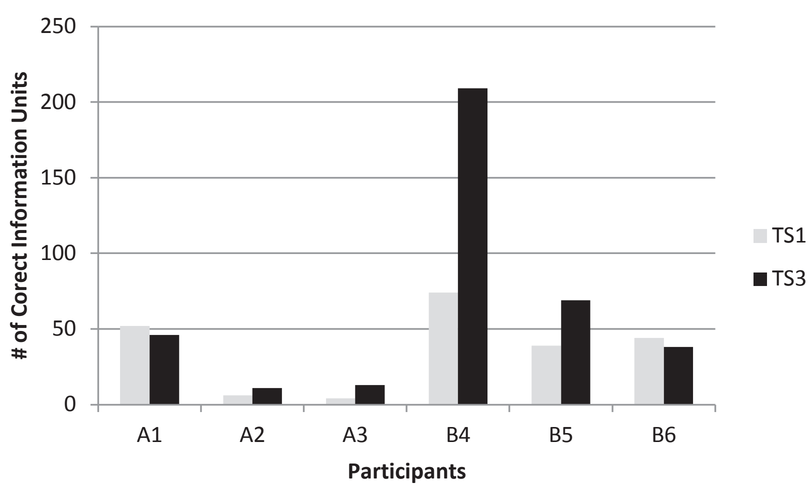

Figure 3. Correct Information Units (CIUs) at TS1 and TS3 for each participant.

faction. Table 5 presents the mean and median data across participants for each individual question.

DISCUSSION

Findings showed support for using an intensive computer-assisted treatment for anomia to improve word finding abilities in persons with chronic aphasia. The Parrot Software programs in this study utilized a combined semantic, phonological, and/or orthographic treatment approach to improve word-retrieval through the use of cues, descriptions, and cognitive tasks. The general naming condition within which these programs operated was naming at the single-word level. Improvements in structured confrontation naming did not extend to word finding during oral discourse (picture description) for all six participants; however, 4 of the 6 PWA increased the number of correct information units used during TS3 by 43% to 69%. Participants seemed to experience satisfaction with the intensive computer treatment program for anomia and felt that it was worthwhile and helpful.

Word Finding During Confrontation Naming Tasks

The computerized treatment program implemented in this study had a significant ($p < .05$) positive effect on word finding for all PWA during confrontation naming tasks as measured by the BNT and WAB N&W. Improvement occurred for untrained words, indicating possible generalization of cueing strategies learned/practiced on the computer to other contexts. All participants' scores increased over baseline (TS1) to TS3. Additionally, scores for Subgroup A increased from baseline (TS1) to first post-test (TS2) and then remained relatively stable following a 4-week no-treatment phase (TS3), indicating maintenance of treatment effects. Subgroup B's scores remained stable from baseline (TS1) to baseline two (TS2) during a period of no-treatment and then increased following the 4-week treatment period (TS3), indicating that the change could be attributed to the treatment program.

In addition to statistical significance, the large effect sizes, or magnitude of the differences in scores between baseline (TS1) and poststudy (TS3), ap-

TABLE 5. Results of Program Evaluation Inventory—Short Form by Question

	Participant							
Statement on PEI-SF	**A1**	**A2**	**A3**	**B4**	**B5**	**B6**	**Median**	**Mean**
1: I find this program to be an acceptable way of helping individuals with communication problems as a result of stroke.	96.77	95.83	63.89	80.56	88.89	94.44	91.67	86.73
2: I like the procedures used in this program.	96.77	98.61	97.22	70.83	88.89	91.67	94.22	90.67
3: I believe this program is likely to be effective.	95.16	97.22	50.00	70.83	91.67	91.67	91.67	82.76
4: I did not experience any discomfort during the program.	96.77	34.72	97.22	83.33	75.00	83.33	83.33	78.40
5: I believe this program is likely to result in communication improvement.	96.77	98.61	55.56	81.94	86.11	91.67	88.89	85.11
6: I believe it would be acceptable to use this program with individuals who have similar disorders.	98.39	97.22	55.56	98.61	88.89	88.89	93.06	87.93
7: Overall, I have a positive reaction to this program.	100	97.22	97.22	72.22	90.28	94.44	95.83	91.90

pear to be clinically relevant. If PWA can improve their word finding abilities within a 4-week period such that they are more adept at finding words when placed "on the spot" (i.e., in a confrontational naming situation), they may benefit from intensive computerized treatment; however, further research is needed to determine whether or not changes on the measures actually affect real-life change.

The positive effect on word finding in confrontational naming tasks as indicated by results of the BNT and WAB N&W is similar to the results from Doesborgh et al. (2004) who found that following an impairment-oriented treatment utilizing the computer program Multicue, significant beneficial effects for confrontation naming occurred. Multicue specifically addresses confrontational naming with a cueing hierarchy, similar to many of the Parrot Software programs used in the current study. Multicue is a computer program that facilitates word-finding by utilizing a variety of cues to stimulate the user's ability to recall target words (Van Mourick & Van de Standt-Koenderman, 1992). Parrot Software also uses semantic (i.e., category, function, location, appearance, fill-in-the-blank), phonemic (i.e., first sound, PWA's own production of target, and auditory repetition of target by program), and orthographic (i.e., first letter, spelling, target in a sentence, and target in a list) cues to stimulate retrieval of target words. Perhaps via repeated practice, PWA become more adept at internalizing the use of these types of cues so that they can retrieve words more efficiently.

Word Finding During Oral Discourse

Four of the six PWA improved their message informativeness during oral discourse as measured by the number of correct information units (CIUs) produced. Although the Parrot Software programs used in this computerized anomia treatment protocol did not directly address word finding at the discourse level, the possibility of generalization of word finding skills during connected speech/discourse exists (e.g., del Toro, Altmann, Raymer, Leon, Blonder, & Rothi, 2008). Two of the six participants in the current study showed slight decreases (12% and 14%) in the number of CIUs produced at TS1 compared to TS3. In terms of their informativeness during oral discourse, no positive changes were noted at the end of treatment compared to baseline. Four of the participants in this study demonstrated gains as measured by CIUs during picture description discourse. If PWA could improve their ability to retrieve words in a variety of speech contexts (e.g., single item naming, informativeness during oral discourse) as a result of intensive computer-assisted anomia treatment, this may be a clinically as well as socially relevant finding. However, further research is needed before such assumptions can be made. Recent and promising research (e.g., Cherney, Halper, Holland, & Cole,2008) has investigated computerized discourse-level script training and oral unison reading methods for improving speech output beyond the single word level. The potential for computerized training programs that could be implemented by PWA in their own homes and result in improved oral discourse provides hope for continued improvement long after the onset of aphasia.

Program Satisfaction

Average responses to all questions on the PEI were above the 75th percentile, indicating a positive view of the treatment program. The lowest mean score of 78.4 was given on Statement 4: "I did not experience any discomfort during the program." When the researcher informally probed this statement further, responses from most participants indicated that leaving the research lab to use the restrooms was inconvenient because the restrooms were not conveniently located in close proximity to the research lab, and the individuals sometimes required assistance with mobility. Excluding this question, all mean and median responses were greater than 80% approval, indicating an overall satisfaction with the procedures and methods implemented during this treatment program.

CONCLUSIONS

The major findings of this study indicate that PWA improved their ability to name single pictured items and actual objects that were not directly trained/targeted following 4 weeks of this intensive computer-assisted anomia treatment, indicating possible internalization of word finding strategies that generalized to untrained words. The treatment-first subgroup (Subgroup A) demonstrated this ability following 4 weeks of no treatment at the final testing session (TS3), indicating some maintenance of word finding skills beyond the treatment period. Four of the six participants improved their word finding in terms of message informativeness (as measured by CIUs) during oral discourse, indicating possible generalization of word finding abilities during connected speech for some individuals;

however, further research is needed. The generalization of this study is limited because of the small number of participants and lack of a control group. It is suggested that future research efforts focus on designing well controlled studies with sufficient participants so that the results can be generalized. Furthermore, it is possible that the intensity of treatment in this study may have contributed to the results. Because intensity of treatment was not a variable that was investigated in this study, it is important to investigate the role of intensity of treatment in changing target behavior in PWA in future studies. Additionally, future studies should address whether effects could be maintained for a longer duration (> 1 month) using a less intense schedule of treatment. In sum, when using a particular treatment schedule, previously untested software programs produced a measurable effect and some qualified success at word finding in a heterogeneous group of PWA.

Disclaimer: The authors purchased the software programs used in this study and have no financial agreements with Parrot Software.

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APPENDIX A
Computer Trouble Hierarchy

❑ Computer Operations

If: Computer is not responding
Then:
- Confirm that mouse/keyboard/headphones are plugged in.
- Provide one-minute wait time.
- Restart program.

If: No sound is coming out of the earphones
Then:
- Make sure volume on the computer is turned on.
- Turn up volume.
- Restart program.

If: The program shuts down from an error
Then:
- Confirm error number and record.
- Restart program.
- Facilitate choice of lesson number if appropriate.

APPENDIX B

Content Cueing Hierarchy

❑ Content of Treatment

If: A participant asks questions about the instructions for a program
Then:
- Point to and/or replay on-screen instructions.
- Repeat instructions verbally.
- Rephrase instructions.
- Give example problem not included in program.

If: A question about what is required of the participant is asked
Then:
- Point to and/or replay on-screen instructions.
- Rephrase instructions.
- Point to computer input devices necessary for the program.
- Demonstrate the use of input devices.

If: Any question is asked by a participant about a program's content
Then:
- Play on-screen instructions.
- Rephrase instructions.
- Read and/or point to stimuli on the page.
- Ask participant to re-auditorize the instructions and/or stimuli