Critical Review: The Efficacy of Computer-Provided Treatment for Individuals with Aphasia

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This critical review examines the efficacy of computer use for treating individuals with aphasia. A literature search was conducted and the following designs included: review (1), randomized control trial (1), case study (1), multiple baselines (2), outcome study (2), multiple single case (1). Overall, there is limited evidence to support the efficacy of computer-provided treatment for individuals with aphasia. Many reports have found computers to be effective for this population, but only a few have applied strictly controlled parameters to be considered truly efficacious. Recommendations for speech-language pathologists as well as suggestions for future research are also provided.

Introduction

Aphasia is defined as "an acquired communication disorder caused by brain damage, characterised by an impairment of language modalities: speaking, listening, reading and writing" (Chapey, 2001, pg. 3). Both expression (e.g. speech) and comprehension of language is impaired to some extent. This disorder primarily affects older individuals and is most common in stroke survivors (Steele, Aftonomos, & Munk, 2003), while the degree and type of communication impairment incurred depend on the site and extent of brain damage. Many methods have been used to rehabilitate language in individuals with aphasia. One increasingly widespread technique involves the use of computers in therapy.

The advantages of computer-provided therapy for people with aphasia include additional self-paced and individual practice for the client. The client can also be provided with more consistent and controlled stimuli with automatic feedback (Steele et al., 2003). In addition, computers are seen as a way for individuals to gain more independence, relying less on the therapist and family (Nicholas, Sinotte, & Helm-Estabrooks, 2005). Conversely, there is the cost of software packages, computers (in the clinic as well as at home for clients in most cases), and the time spent individualizing the program for the client. Due to the focus on cost-effectiveness in clinics, the progression of such high-technology treatments in the speech-language pathology field has been a measured one (Steele et al., 2003).

Furthermore, there are constraints in the empirical efforts to investigate computer use in therapy due to limits imposed by clinical research. New therapies must first be established as *efficacious*, active in optimal environments, before being considered *effective*, active in typical conditions. Unfortunately, the terms efficacy and effectiveness are often used interchangeably (Katz & Wertz, 1997; Wertz & Katz, 2004). Such inconsistent terminology has possibly led to many studies being erroneously labelled efficacious.

Objectives

The primary objective of this paper is to critically evaluate the existing literature concerning the efficacy of computerized therapy for individuals with aphasia. The secondary objective is to propose evidence-based practice recommendations for future research and clinical practice regarding computer use in the rehabilitation of persons with aphasia.

Methods

Search Strategy

Computerized databases including CINAHL, AMED, Communication Sciences and Disorders Dome, and MEDLINE were searched using the following search strategy: (aphasia) AND (therapy) AND (computer). The search was limited to articles written in English between the late 1990s and 2007.

Selection Criteria

Studies selected for inclusion in this critical review were those researching computer-based intervention for individuals with aphasia under controlled conditions.

Data Collection

Results of the literature search generated the following types of articles matching the selection criteria above: review (1), randomized control trial (1), case study (1), multiple baselines (2), outcome study (2), multiple single case (1).

Results

Review

Wertz and Katz (2004) reviewed 16 studies, two of which are included in this critical review, which focus on implementing computers in aphasia therapy. The papers consisted of case studies, comparison studies, single-subject designs, single-case studies, outcome studies, a retrospective study, a cross-over design, and a randomized control trial. Wertz and Katz applied a five-phase treatment outcome research model instituted by Robey and Schultz (1998) in their evaluation of these studies. The authors suggested that these phases be a guideline in research to move from establishing purposes and hypotheses (Phases 1 and 2) to conducting studies that will lead to efficacy, effectiveness, and efficiency (phases 3,4, and 5 respectively). According to Wertz and Katz, only one study achieved efficacy - a randomized control trial design by Katz and Wertz (1997). They concluded that much of the evidence given from their reviewed studies constituted class III evidence. Consequently, they insisted that further studies are needed to provide more support for the efficacy of computer use in aphasia therapy.

This review contains a detailed outline of its plan, purpose, methods, and procedures; nonetheless, there are crucial details missing concerning the manner in which treatments were conducted, including any blinding or inclusion/exclusion criteria, which limits the validity of Wertz and Katz's inferences. It is unclear, however, whether such details were originally given in the reviewed studies themselves. In addition, while each phase of the applied model clearly indicates where each article belongs, there was no statistical information such as confidence intervals, heterogeneity or moderator analyses to evaluate their findings more empirically. Finally, considering that the authors' study was the only one to achieve a level of efficacy, this suggests the possibility of experimental bias.

The following is a critical review of the paper Wertz and Katz deemed efficacious.

Randomized Controlled Trial

Katz and Wertz (1997) examined the efficacy of a computer-based reading therapy for individuals with chronic aphasia. Fifty-five adults were randomly divided into three groups: 1) a computer reading treatment group, 2) a computer stimulation group, and 3) a group receiving no treatment. The study lasted 26 weeks, with the first two groups receiving three hours of clinical therapy per week. Language measures (13 in all, from the *Western Aphasia Battery* and the *Porch Index of Communicative Ability*) were administered pre-treatment, after three months, and post-treatment. The computer reading treatment software included matching and reading comprehension tasks while the stimulation group played games, which focused on attention span and memory rather than language. There was limited clinician interaction with the participants aside from verifying attendance, introducing tasks, and monitoring performance. A baseline, treatment and test set were administered using the computer software. Change scores (from pre- to post-treatment) for the 55 participants were analyzed using a multivariate analysis of variance (MANOVA). Univariate ANOVA and t-tests were used in post-hoc analyses of significant outcomes. Results revealed a significant difference among the three groups, attributed specifically to five language measures (*PICA* overall, *PICA* verbal, *PICA* Pantomime, *WAB* Aphasia Quotient, and *WAB* Repetition). The computer reading group showed significant improvement on all five language measures, the computer stimulation group on only one measure (*PICA* overall), and the no treatment group showed no significant improvement on any measure. A larger percentage of participants in the computer treatment group met the study's "clinically significant" change criterion on 11 of the 13 measures than subjects in the other two groups. Wertz and Katz concluded the following: computer reading treatment could be administered with limited clinician assistance, progress in the computer reading tasks led to generalization in language performance, improvement was attributed to the software program (and not simply computer stimulation), and the computer reading treatment employed was efficacious.

Katz and Wertz used an adequate, homogeneous sample size with randomization, a significant advantage, which ensures no systematic order to the selection of the sample. In addition, there was consistency in the standardized measures used, the amount of clinician assistance, and the frequency and amount of therapy; however, there was no blinding. Moreover, there were eight individuals who dropped out at the beginning of the treatment but no intention-to-treat analysis was used. Finally, though the final outcomes of the ANOVAs were given, the F-values were not. Despite these weaknesses, the study provided fair to strong evidence that any improvement in language was due to the computer software itself and its application in a rigidly controlled setting.

Case Study

Fink, Brecher, Sobel, and Schwartz (2005) outlined two aphasia mini case studies of individuals with word retrieval deficits, who underwent a computer-assisted treatment. The software, *MossTalk Words,* used a large vocabulary with exercises

tailored to each individual. AS was a 65-year-old man who suffered a left-hemisphere cerebrovascular accident five years previous, and used the program at an aphasia centre. He underwent cued-naming and multi-modality matching exercises for verbs as well as sentence level therapy to improve subject-verb utterances. Verb naming tests were administered before each session for trained and previously named (but untrained) verbs. Performance on trained and previously named verbs improved as did the production of trained and untrained S-V utterance tasks. Another individual, SB, was a 45-year-old woman who suffered a stroke three years previous and underwent the treatment in a computer lab. Her verbal expression, auditory comprehension, reading, and writing were severely impaired. SB worked at the computer lab once a week with a trained volunteer and at home approximately 40 minutes a day, five-six days per week. Sessions included the use of a functional vocabulary set in word-picture matching and cued-naming tasks. By three years into the program, SB worked on over 100 words and was able to independently name these words with 40-80% accuracy.

Although both aforementioned case studies attempted to show the usefulness of *MossTalk Words* in real-life situations, both are missing essential information. For instance, the frequency of therapy in both cases was missing. In addition, although there were improvements for each patient, their results do not lend themselves to statistical analysis due to the lack of data given as well as the small sample size, which prevents any generalization of the results. The conclusions reached by Fink et al. also took into account their own previous studies. They suggested that this computer program is user-friendly, promotes independent use, and is cost-effective when used by subjects in their homes. However, these conclusions cannot be derived from the limited information given from their case studies or previous studies.

Multiple Baselines

Nicholas et al. (2005) examined computer use in communication, focusing primarily on executive function impairments in people with severe aphasia. Five participants with similar personal characteristics used the *C-Speak Aphasia* program. All subjects were at least one year post onset with severe non-fluent aphasia, moderate to severe auditory comprehension, and similar scores on the *Boston Diagnostic Aphasia Examination-BDAE-3*. Baseline assessments included the *BDAE-3* (for language), subtests of the *Cognitive Linguistic Quick Test* (for cognition), semantic tasks (selecting the correct category for a word or picture), and five functional communication tasks, which were probed repeatedly throughout the treatment. Functional tasks included responding to personal questions, describing pictures and a non-verbal video, making telephone calls, and writing a birthday card and grocery list. Each participant acted as his own control and received at least six months of treatment, two hours per week. The information expressed by each participant during the functional tasks was compared across two conditions, using and not using *C-Speak* (i.e. on-computer and off-computer). Difference scores for each participant were attained by subtracting mean scores of the baseline functional communication tasks from that of all the functional communication probes administered during the intervention. Some preservation of non-linguistic cognitive skills was found, indicating a superior response to the *C-Speak Aphasia* training. This was determined by a significant correlation between the summed *CLQT* score from baseline and the composite change score in the on-computer condition only; conversely, the *BDAE-3* Auditory Comprehension subtest and the semantic tasks showed no significant correlation. Further calculations showed a significant correlation between the composite change score and the Design Generation subtest of the *CLQT*, suggesting that executive function skills are more relevant to treatment response than semantic abilities or auditory comprehension.

In another multiple baseline paper, Raymer, Kohen, and Saffell (2006) conducted a single-patient study, examining the effects of computerised training for word retrieval and comprehension in five individuals with aphasia; they used the Multi-Mode Matching Exercises module of *MossTalk Words* (consisting of spoken, written, and spoken & written word/picture matching) for two subjects with semantic anomia and three with phonological anomia. Participants varied from four months to several years post stroke, all showing different aphasia patterns on the *Boston Naming Test* and the *WAB*. All subjects were involved in two phases of treatment administered, 1) 1-2 times per week and 2) 3-4 times per week (the order of administered phases was counterbalanced among subjects) for 12 two-hour sessions. Probes (consisting of picture naming and word/picture yes/no verification for the same 60 nouns) were administered for 3-5 baseline sessions. Reliability of scoring was inspected by a second examiner for 15% of the sessions. Effect sizes were calculated (>2.5 was considered large) to discover acquisition effects among participants. Phase one treatment found some therapy improvement; however, all participants showed picture naming gains in phase two treatment. Improvement was also seen in untrained picture naming sets in 3/5 participants. Maintenance probes administered at one

month post-treatment indicated that naming performance remained well-above baseline measures; however, little apparent distinction existed between the two phases of treatment, suggesting that frequent versus infrequent training did not differ in the end. There were generalized improvements for untrained words, applying only to phase two training, which the authors attributed to increased frequency of training. The subjects did not show significant gains in standardized aphasia tests.

Although Raymer et al. (2006) had a control measure (the untrained word sets) which increased their report's validity, their study was restricted by their limited number of training sessions compared to other studies; therefore, while training effects were clear, the participants were not able to reach the criterion levels within the limited timeframe of the study. Although both studies administered standardized measures pre-treatment, Nicholas et al. (2005) focused post-treatment measures on non-standardized functional communication only and Raymer et al. (2006) focused their conclusions on effect sizes. Neither study detailed language measurement findings post-treatment. The lack of standardized tests is understandable, however, given the possibility of repeat testing effects and the inability of these standardized tests to detect smaller changes. Nevertheless, Nicholas et al.'s study thoroughly analyzed which test accounted for evidence that executive function skills were important for success with the *C-Speak* program. This correlational analysis may be questionable; however, as all five participants were cumulatively considered in this relationship between baseline and later measures.

Outcome Studies

Aftonomos, Steele, and Wertz (1997) conducted a retrospective study, investigating the effects of an interactive technology called *Lingraphica (LG) System* for 23 individuals with chronic aphasia. This study was also included in Wertz and Katz's (2004) review discussed above. Participants from an aphasia centre (20) and a veterans' centre (3) ranged from six months to more than 15 years post–onset, with a wide range of types and severities of aphasia. All participants but two at the veterans' site had hour-long sessions twice a week (two patients were treated in two hour blocks with overlapping sessions). At the aphasia centre, *LG* therapy content varied extensively due to wide ranging aphasia types and severities. The *PICA* was administered before and after 40 hours of treatment at the veterans' centre, while the *BDAE* and/or the *WAB* and/or the *BNT* were administered at intake and discharge at the aphasia centre. Score means pre- and post-treatment were not found to be statistically significant when compared using a one-tailed, matched t-test. The authors inspected individual differences and found that 21 participants improved while the 9 administered the *WAB* did not. However, for both the *BDAE* and *WAB* calculations, mid-range scores were the only ones included (15%-85%) to eliminate floor and ceiling effects. The authors suggested that a wide range of aphasia types were able to improve in different language modalities using the *LG* program and that improvements were most likely due to frequent and prolonged practice at home.

Aftonomos, Applebaum, and Steele (1999) conducted a multicentre outcome study as well, recruiting participants from two comparably managed community-based therapy programs. The 60 individuals varied significantly in aphasia types, severities and times post-onset. Inclusion criteria included the presence of aphasia, at least one month of therapy in the community-based program, and the administration of the *WAB* pre- and post-treatment to assess impairment levels. The *Communicative Effectiveness Index (CETI)* was also administered pre- and post-treatment to assess functional communication. A considerable number of participants, however, were not given the *CETI* (31) or certain *WAB* subtests (32). Hour long sessions, which consisted of multimodal exercises from *Lingraphica* were administered according to aphasia type and severity; exercises were also given to do at home. Pre- and post-treatment scores were compared using a one-tailed matched t-test, demonstrating significant importance in all measures assessed at the impairment and functional levels. One-way ANOVAs subsequently detected no difference between different subgroups (e.g., acute vs. chronic, different severity levels, sites, etc.). A Chi squared test further deduced that 29 of the 46 participants with chronic aphasia showed no change of diagnostic category after treatment while 17 assumed a less severe diagnosis.

Both of these aforementioned studies have at least an adequate sample size but no randomized design; subjects also varied widely in terms of aphasia types, severity, time post-onset, age, etc. However, post-hoc analyses revealed no difference based on these parameters. A potential source of error includes non-uniform administration of assessment measures pre- and post-treatment, which calls into question the overall validity of the authors' findings. In addition, the time spent at home doing exercises was not accounted for in the final measurements, which may account for some of the individuals' differences. This analysis of Aftonomos et al.'s 1997 paper is also consistent with the conclusions reached

by Wertz and Katz in their 2004 review, which also deduced a lack of efficacy.

Multiple Single-Case

Laganaro, Di Pietro, and Schnider (2003) evaluated the effects and feasibility of an unsupervised computer assisted therapy (CAT) for anomia in chronic outpatients (4), and acute inpatients (7). Participants had a severe-moderate anomia diagnosis, no severe comprehension impairments, relatively independent use of computers, and the ability to maintain attention for at least 30 minutes. In addition, all but two patients were native French speakers. CAT programs were unsupervised and customized for each individual's particular anomic syndrome. Outpatient individual sessions alternated with an equal number of clinical therapy sessions, while inpatients added CAT to their daily therapy sessions. Baseline and post-treatment measures included oral picture naming tasks. Three lists of 48 words (one for CAT, one for clinical therapy, and one as the control which was left untreated) were randomly assigned across participants. The outpatients received two-three CAT sessions per week for two weeks. For inpatients, two periods of CAT and individual therapy was alternated with individual therapy only. Due to the heterogeneity of the sample, multiple single-case analyses were performed. McNemar's Chi squared for repeated measures was calculated to determine improvements after each assessment period while Pearson's Chi squared compared treated versus non-treated lists. Results indicated that two participants in the chronic aphasia group performed better on the treated versus the untreated list. Four outpatients, compared to 3/7 inpatients, showed item-specific improvement in CAT. Effects in the chronic group were maintained after a two week follow up period for the treated list. Using the Chi squared tests, oral naming improvements were clearly linked to CAT for the 3/7 participants in the acute phase, providing evidence of a potential therapy affect and suggesting the possibility of measuring improvement despite the presence of spontaneous recovery. The authors suggest that their results provide some evidence for the efficacy of CAT for anomia, both in isolation and as an addition to clinical therapy.

Laganaro et al.'s (2003) paper uses a very small sample size with a wide variety of participant characteristics which hinders any generalization of these findings. In addition, despite the presence of a control group, there was no randomization of subjects or blinding to the tasks. Each activity was customized which suited the participants' individual needs, but did not provide equivalent measures and tasks, therefore creating more non-uniformity in the design. Other inconsistencies are seen in the different therapy routines of the two subgroups. The logical psychometric data that were collected increased the reliability of the results, although no standardized language measures were taken pre- or post-treatment.

Conclusions and Recommendations

A critical review of the literature demonstrates promising evidence that computers can be a useful method of delivering treatment for those with aphasia. All studies reviewed exhibited some improvement in language for participants as a result of computer use. However, there are several limiting methodological factors to take into account when examining these studies for evidence of efficacy. Apart from one randomized control trial by Katz and Wertz (1997), which provided fairly strong evidence of the efficacy of computer use in aphasia therapy, the majority of studies did not employ rigidly controlled designs in order to be considered efficacious. Overall, these studies did not have adequate homogeneous sample sizes to generalize to a larger population. As well, the outcomes found in these papers were not always based on standardized language measures. Furthermore, in most cases, the feasibility of computer use in a clinic, at home, and the time spent learning the software program for an individual with aphasia were not discussed.

In conclusion, at this time there is guarded support for the efficacy of computer use in therapy for individuals with aphasia.

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