Critical Review:
The effectiveness of self-administered, technology-based anomia therapy in patients with chronic post-stroke aphasia

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This study reports a critical review exploring the effectiveness of self-administered, technology-based (computer or tablet interface) anomia therapy for patients with chronic post-stroke aphasia. For the critical review, studies evaluated included six articles of varying study design (randomized controlled trial, single subject design, and case studies). Overall, the results of this paper suggest that self-administered, technology-based therapy is an effective form of treatment for chronic post-stroke aphasia patients with anomia.

Introduction

Aphasia develops in roughly 30% of first-time ischemic stroke patients and is often chronic (Lalor & Cranfield, 2000). Anomia, or impairment of word finding, is the most common symptom of aphasia and occurs in spontaneous speech and/or written production and thus has a significant impact on daily communication (Lavoie, Routhier, Légaré & Macoir, 2016; Ramsberger & Marie, 2007). Approximately 50,000 Canadians suffer from a stroke each year, and as the population ages this incidence is likely to increase (Heart & Stroke Foundation, 2014).

In many countries, constraints in personnel, finances and time can decrease availability and/or intensity of, language therapy services (Lavoie et al., 2016). Alternative service delivery methods have been explored and the use of tablets and computers offers a potential solution to this problem. Varley (2011) states that the use of these devices is now common across all age groups. Among adults and older adults in the United States, the prevalence of tablet-use has been steadily increasing, with 49% and 18% of tablet owners ages 35-44 and age 65 and above, respectively.

Ramsberger and Marie (2007) explained that the software programs and applications on computers and tablets can be used to automatically present therapy stimuli and can often integrate levels of cueing. For instance, following a picture or video cue, the client says, writes or thinks their response. The advantage of this form of therapy is the massed practice, which is both repetitive, and personalized (Kurland, Wilkins & Stokes, 2014). Additionally, this technology can be independently accessed from home, thus promoting autonomy and is ideal for those patients seeking additional practice or for those that live remotely and cannot access services (Wade et al., 2003).

Although there is current evidence for technology-based therapy for post-stroke aphasia patients, there is accumulating evidence that when administered independently, this therapy is effective in treating anomia (Palmer et al., 2012). Technology-based therapy has the potential for high-intensity practice as an adjunct to traditional one-on-one therapy or as a maintenance program (Routhier, Bier, & Macoir, 2016).

Objectives

The primary objective of this paper is to critically review the existing literature examining the effectiveness of self-administered, technology-based anomia therapy in patients with chronic post-stroke aphasia.

Methods

Search Strategy

Online databases including: PubMed, Web of Science and Google Scholar were searched using the following terms:
[(aphasi*) AND (technolog*) OR (computer*) OR (ipad*) OR (app*) OR (tablet*) AND (anomi*) OR (nam*) AND (treatment*) OR (therap*) OR (intervention*)]. Reference lists of included articles were also used to obtain other relevant articles.

Selection Criteria

Studies examined included interventions implementing technology-based anomia therapy for chronic post-stroke aphasia patients.

Data Collection

The literature search resulted in the selection of six articles that met the selection criteria. These articles included one randomized controlled trial (Palmer et al., 2012), three single subject studies (Choe, Azuma, Mathy, Liss, & Edgar, 2007; Kurland et al., 2014; Ramsberger and Marie, 2007), and two case studies (Lavoie et al., 2016; Routhier et al., 2016)

Results

Randomized Controlled Trial (RCT)

According to Archibald (2018), RCTs are a rigorous prospective study design with a between-groups design to investigate a cause-effect relationship. Confounding variables are controlled through randomization and these study designs should also incorporate double blinding. However, RCTs are often time-consuming and are not always ethical, as the one group is withheld from treatment.

Palmer et al. (2012) conducted an RCT pilot study examining the effectiveness of a 5-month, self-managed computer treatment program for word-finding practice, among chronic post-stroke aphasia patients.

Participants included 33 individuals with aphasia at least 1-year post-stroke with word-finding difficulties (age 37-83). The study included an intervention group (n=16), as well as a control group (n=17) that continued usual care (everyday language activity). Volunteer support was provided to only three-quarters of the patients in the intervention group, due to availability. The intervention group used the program three times per week to practice 48 words that were gathered from their baseline assessment measure.

Outcome measures included the use of a gold standard test of naming at baseline, immediately and 3-months post-treatment for maintenance measures. Additional measures included treatment feasibility measures and both the clinical and cost-effectiveness of the treatment, of which only the former is relevant to the present review.

Appropriate statistical analysis was performed. Strengths of this study include the detailed descriptions of inclusion and exclusion criteria and methods, as well as its randomization of participants into groups following the baseline assessment. Moreover, there was a wide and even distribution of ages, and a relatively equal distribution of the participants between the two groups based on their language domains. It was further strengthened through blinding of the speech-language pathologist (SLPs) performing the assessments. Weaknesses of this study include its small sample size and poorly detailed methods on stimuli presentation and cueing. Another weakness was the participant dropouts in the intervention group (n=13, n=11) and control group (n=15, n=13), at the 5 and 8-month measures, respectively. Although the dropout numbers are similar across the two groups, this may have impacted the results of the study, as analysis only included the data of 28 and 24 participants, for each measure, respectively. Lastly, reliability was not reported, thus further weakening this study.

Results revealed that the intervention group showed improvement in their naming abilities from baseline and at 5-months between groups. Compared to the control group, the intervention group experienced a greater percentage change at 3-months post treatment, indicating a maintenance effect.

Overall, this study provides highly suggestive evidence that self-managed, computer anomia therapy with minimal SLP and volunteer support, is a feasible form of intervention for post-stroke aphasia patients.

Single Subject Design (SSD)

As outlined by Archibald (2018), SSDs are the systematic manipulation of the variable(s) and are suitable for comparing treatment effects. An ABA design more clearly establishes causality. However, the participants act as their own controls and these studies must be interpreted cautiously due to their small sample size.

Choe, Azuma, Mathy, Liss, and Edgar (2007) conducted an SSD that examined the effectiveness of a 13-week, home computer-based picture naming therapy program on the naming performance of patients with chronic nonfluent aphasia and verbal apraxia.

Participants included four individuals with nonfluent aphasia at least 1-year post-stroke (age 48-76). All participants were assigned to all three conditions concurrently (daily computer practice, weekly therapy sessions and no practice). Each participant's performance on the baseline assessment task determined their three sets of ten target words that were assigned to each condition. The computer program involved practice of these words daily.

Outcome measures included the use of gold standard tests of naming as well as a study specific measure of picture naming. Measures were taken at baseline and during treatment sessions five and nine. Maintenance measures were taken immediately and 5-weeks post-treatment.

Appropriate statistical analysis was completed. Strengths of this study were the detailed methods, as they included descriptions of the stimuli presentation and cueing. Moreover, inter- and intra-rater reliability was indicated to be high. However, this study is weakened by the omission of both eligibility criteria and reporting of blinding.

Results showed that with computer practice, two participants' naming significantly improved from baseline to post-treatment. Moreover, within the computer condition, three participants significantly improved from baseline to 5-weeks post-treatment, indicating a maintenance effect. With weekly practice, only one participant improved significantly from baseline to post-treatment, with no improvements maintained at 5-weeks post-treatment. Lastly, there were no significant improvements in the control condition.

Overall, this study provides suggestive evidence that a home computer naming therapy program is effective in improving and maintaining the naming ability of patients with chronic nonfluent aphasia and verbal apraxia.

Kurland, Wilkins and Stokes (2014) conducted an SSD that investigated the effectiveness of a 6-month iPad-based word-retrieval individualized home practice (HP) pilot program, for people with chronic post-stroke aphasia.

Participants included eight individuals at least 8-months post-stroke with nonfluent aphasia (age 55-81). Prior to the HP programs, participants underwent a 2-week intensive language therapy program that involved the training of 20 words that they were unable to name in all three baseline tasks. These words later became part of the two 20-word lists used in the therapy phase, and four conditions were created: trained (TR) words from the 2-week language program and untrained (UNTR) words to be practiced (PR) in the HP program, and TR and UNTR words that were not to be practiced (UNPR). The HP program involved practice of these words 5-6 days per week.

Outcome measures included the use of subtests from gold standard naming tests at baseline, and immediately post-treatment for maintenance measures, as well as the performance on the word lists as monthly probes to examine the generalization effect to those untrained words.

Appropriate statistical analysis was performed. Strengths of this study include its detailed descriptions of methods and its randomization of participants to the 2-week intensive therapy program. However, weaknesses include the omission of inclusion criteria and small sample size. This study was further weakened by two participant dropouts, and the analysis of only 5/6 participants' data. Lastly, reliability and blinding were not reported, thus further weakening this study.

Results revealed achievement of clinical significance on all words practiced in the HP. Moreover, all participants showed trending toward maintenance or continued improvement of the TR-PR words. For UNTR-PR words, all participants demonstrated strong evidence of a treatment effect, while most participants (4/5) demonstrated dramatic gains in these words. The UNTR-UNPR condition remained relatively unchanged for all participants, indicating no generalization effect.

Overall, this study provides suggestive evidence that the naming gains made during the 2-week intensive language program can be maintained and improved over the use of a 6-month iPad HP program among chronic post-stroke aphasia patients.

Ramsberger and Marie (2007) conducted an SSD study that examined the effectiveness of a self-administered, clinician-guided, computer-based, cued naming therapy for post-stroke chronic aphasia patients.

Participants included four individuals with aphasia at least 6-months post-stroke (age 63-74). The study included multiple baselines across behaviours and two treatment intensity schedules. Intense (5 days/week) and non-intense (2 days/week) schedules each involved the same number of sessions and were replicated over the participants in two treatment phases. Each participant's mean baseline naming performance on 100 nouns was used to develop two 40-word lists; one list for each phase.

Outcome measures examined performance on the lists every fifth session during the treatment phase. Maintenance measures were taken during treatment phase two, by testing performance on the first list of words that were trained during treatment phase one.

Appropriate statistical analysis was performed. Strengths of this study include the detailed descriptions of inclusion criteria and randomization of participants to the initial treatment schedule. However, weaknesses include the limited details regarding their methods and stimuli presentation (such as study timeline and details of post-measures). It is also weakened by the lack of reporting of reliability and blinding of the researchers. Lastly, this study was limited by a very small sample size with a narrow distribution of ages.

Results showed strong evidence of improved naming of trained words, regardless of treatment intensity, for 75% of the participants. Moreover, there was strong and moderate maintenance evidence for one and three of the participants, respectively. Regarding generalization to untrained words, 50% of participants showed weak evidence, indicating a poor generalization effect.

Overall, this study provides somewhat suggestive evidence for the effectiveness of a self-administered, computer-based cued naming intervention for post-stroke chronic aphasia patients, regardless of treatment schedule. Evidence for maintenance was found but was weaker for generalization.

Case Studies:
Case studies are beneficial in directing future research, but they are inherently limited in external validity, and cannot be generalized to a larger population. However, if the findings are used to develop a larger study, then the described treatment method can gain further credibility.

Lavoie, Routhier, Légaré, and Macoir (2016) tested the efficacy of a 3-week, self-administered, tablet-based treatment for improving written verb naming skills in a patient with chronic nonfluent aphasia and severe apraxia of speech.

The participant (age 63) had mixed nonfluent aphasia and was 2-years post-stroke. An ABA multiple baseline design was used for comparison of the patient's performance on three equivalent stimuli lists (trained with cues, trained with no cues and not trained (control)). However, the use of cues is not relevant to this present review and focus will be on trained vs. not trained. Two performances on study specific baseline measures of an action picture naming task and a noun-to-verb production task were used to develop each 40-word therapy list. The program involved practice of these words four times per week.

Outcome measures examined performance on the three word lists weekly, to examine efficacy and generalization to untrained words. Outcome measures were also completed at 2- and 3-weeks post-treatment for maintenance measures.

Appropriate statistical analysis was performed. Strengths of this study were its detailed methods, as they included descriptions of the stimuli presentation. It was also strengthened by its ABA multiple baseline design, high rating agreement (for baseline and efficacy/follow-up/generalization) and blinding of the second experimenter during baseline measures. However, weaknesses include its short protocol duration and the fact that randomization was only implemented on the word lists for the efficacy and generalization measures.

Results showed a very large increase in the participant's naming scores for the cued list, from baseline to end of treatment phase and 2 and 3-weeks post-treatment, thus indicating a maintenance effect. Moreover, there was a very large effect size for baseline vs. treatment end and 3-week follow-up. Performance in the control list improved slightly in the maintenance phase.

Overall, this study provides suggestive evidence for the effectiveness of a self-administered iPad training for the improvement and maintenance of written naming skills in chronic aphasia.

Routhier, Bier, and Macoir (2016) tested the efficacy of and satisfaction with a 5-week, self-administered, tablet-based verb anomia therapy among two patients with chronic post-stroke aphasia.

Both participants (age 51 and 61) had aphasia, were at least 1-year post-stroke and presented with a severe verb naming impairment. Three 25-word therapy lists (trained cued, repeated and control) were created using data from three study specific baseline measures of verb naming, verb comprehension and verb-to-verb production. The use of a trained cued list of verbs and a repeated list of words, determined the specific effect of the treatment and the presence of a repetition effect, respectively. However, the use of cues is not relevant to this present review and focus will be on trained vs. control. The program involved practice of these words four times per week.

Outcome measures included completion of a study specific verb naming measure weekly and at 2-, 4- and 8-weeks post-treatment for maintenance measures.

Appropriate statistical analysis was performed. Strengths of this study include its detailed inclusion and exclusion criteria and methods. As a result, the study is highly replicable. It was further strengthened by the randomization of stimuli presentation for each session, as this prevents an order effect. Moreover, the three raters were blinded for the verb-to-verb production task at baseline. Lastly, there was a high inter-rater agreement during baseline measures. However, it is weakened by a short protocol duration.

Results showed that with the trained cued list, both participants improved their verb naming abilities and were very satisfied with the treatment and tablet-use. One patient maintained their gains up to 8-weeks post-therapy, suggesting a maintenance effect. No repetition effect and no generalization was found for untreated verbs or for treated verbs in a novel task.

Overall, this study provides suggestive evidence for the effectiveness of a self-administered, tablet-based, cued verb naming therapy for chronic aphasia patients.

Discussion

Overall, the studies reviewed in this paper provide suggestive evidence that self-administered, technology-based anomia therapy is effective among chronic post-stroke aphasia patients. The demographics of this population included individuals ages 37-83, at least 6-months after a unilateral left hemisphere cerebral vascular accident (CVA). Majority of these individuals presented with a form of nonfluent aphasia.

A total of six articles were included in this review. Four studies were considered to demonstrate suggestive evidence for improving word-finding skills in this population (Choe et al., 2007; Kurland et al., 2014; Lavoie et al., 2016; Routhier et al., 2016), while one study provided somewhat suggestive evidence (Ramsberger and Marie, 2007). In contrast, one study provided highly suggestive evidence (Palmer et al., 2012).

Based on the findings of this review, both computers and tablets are effective forms of technology-based therapy, as three studies examined the latter (Kurland et al., 2014; Lavoie et al., 2016; Routhier et al., 2016). Moreover, the improvements in word-finding skills were seen in nouns and verbs, as two studies examined the latter (Lavoie et al., 2016; Routhier et al., 2016). However, the effect of this therapy on verb anomia is a relatively new area of research, so these case studies are preliminary. Nonetheless, this potential for improvement in verb anomia indicates that a variety of aphasia deficits can be treated with this form of therapy.

Most of the studies included in this review were limited by the study design, as two were case studies, and three were SSDs (Choe et al., 2007; Kurland et al., 2014; Ramsberger and Marie, 2007). The lack of control groups in SSDs is unfavourable and conclusions about whether the results are attributed to the intervention itself, cannot be made. In order to provide compelling evidence of treatment effect, fully powered RCTs should be conducted. Moreover, a larger sample size would determine the generalizability of this form of therapy.

All of the studies varied in the intensity of the self-administered therapy. For instance, the dose ranged from 10 words practiced per session (Choe et al., 2007) to 80 words (Lavoie et al., 2016). The session frequency ranged from three times per week (Palmer et al., 2012) to every day (Choe et al., 2007). Total treatment duration ranged from 3-weeks (Lavoie et a., 2016) to 6-months (Kurland et al., 2014). Notably, one study examined an intense and non-intense treatment schedule and found no difference in the improvements achieved (Ramsberger and Marie, 2007). Since all studies showed evidence of improvement in the participants, it is unclear which therapy intensity is most beneficial.

It must also be noted that all of these researchers had SLPs provide verbal instruction to set the participant up for success. For instance, all studies provided 1-2 one-on-one sessions for training and familiarization with the program. Three studies reported that they provided instruction on how frequently to practice (Choe et al., 2007; Kurland et al., 2014; Palmer et al., 2012), while only two studies reported use of support personnel to initially and continually provide encouragement regarding massed practice (Kurland et al., 2014; Palmer et al., 2012). Therefore, the quality and quantity of the instruction has an importance due to its likely impact on participant buy-in or compliance, and potentially the success of therapy.

Encouragement and positive reinforcement is commonly provided by SLPs during therapy to help maintain client motivation. Aside from intermittent probe testing, clinician involvement was relatively minimal during the at-home treatment phase of these studies. Only two studies provided extra support, which involved weekly informal virtual meetings with the SLP (Kurland et al., 2014), and support and encouragement provided by volunteers via the telephone or a home visit (Palmer et al., 2012). These interactions also involved tailoring of exercises and device assistance. However, it is impossible to measure to what degree patient success was dependent on the support provided at these ‘check-ins’. Interestingly, this support did not result in greater naming improvements compared to the other studies.

Evidence of maintenance effects were found in five studies but there were variations in the time since post-treatment (Choe et al., 2007; Lavoie et al., 2016; Palmer et al., 2012; Ramsberger and Marie, 2007; Routhier et al., 2016). Moreover, some results were inconsistent across participants, with only 50-75% of participants revealing maintenance effects (Choe et al., 2007; Routhier et al., 2016). Among those studies that had highly suggestive evidence for maintaining treatment gains, time post-treatment ranged from 3-weeks (Lavoie et al., 2016) to 3-months (Palmer et al., 2012). This indicates the possibility of a wide range of maintenance effects.

Generalization effects to untreated/untrained words were also examined in four studies, however, results were somewhat unremarkable (Kurland et al., 2014; Lavoie et al., 2016; Ramsberger and Marie, 2007; Routhier et al., 2016). Two of these studies found little

to no evidence of generalization (Ramsberger and Marie, 2007; Routhier et al., 2016), while one study only revealed generalization in lexical verb access (Lavoie et al., 2016) and the other showed strong evidence of a treatment effect on UNTR-PR words only (Kurland et al., 2014). Therefore, in order to provide a patient with the greatest benefit, treated words should be functional or of high personal relevance (Routhier et al., 2016).

A patient satisfaction measure was utilized in some studies, thus providing a degree of face validity. A 5-point scale was used in two studies to rate the features of the computer (Choe et al., 2007) or tablet program (Routhier et al., 2016). Participants in the former study highly rated the digitized speech, word repetition, and automaticity, while the lowest rated feature was lack of feedback. The 26-question 5-point rating scale by Routhier et al. (2016) examined the treatment protocol, and tablet ease of use and technical aspects. The median for each of these three sets of questions across both participants was 5. Most questions received scores of 4-5, with high scored items being treatment/exercises, progress made, pre-treatment tests, probing measures, home therapy, independent therapy, and tablet features. The questions that received a lower score concerned the number of sessions and tablet navigation. Another study reported that good comments were received from their informal patient and family written feedback, noting an increase in self-confidence (Kurland et al., 2014). This indicates that technology-based home therapy is generally well-received by patients.

Conclusion

The studies reviewed suggest that computer or tablet-based, self-administered anomia therapy is effective for and enjoyed by post-stroke patients with chronic aphasia. The effectiveness was evident by the improvements and maintenance of verb or noun naming skills.

Future Research Considerations:
It is recommended that further research be conducted in order to determine the necessity of occasional 'check-ins' by support personnel and the ideal range of treatment intensity. Moreover, maintenance effects should continue to be studied to improve the understanding of the degree of its impact. Research should also further examine the improvements in naming skills in the written modality, as well as verb naming skills. Lastly, future research studies should strengthen the level of evidence through use of strong study designs and incorporate larger sample sizes to increase the confidence of clinical implementation.

Clinical Implications

There is suggestive evidence that therapy can be effectively self-administered through a tablet or computer and can improve and maintain word-naming skills among chronic post-stroke aphasia patients. It is an option for patients who are autonomous, live remotely or are looking for high intensity supplemental home therapy or maintenance program. However, recommendation of this therapy should occur following consideration of patient factors, such as independency, motivation, and accessibility to a tablet/computer. Clinician involvement should at minimum, involve the provision of a training session to enhance client competence and confidence in independent administration of the therapy. Lastly, in order to allow for adequate individualization of the therapy program, selection of stimuli and cueing should be determined by an SLP.

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