The Efficacy of Tele-practice on Expressive Language Outcomes for Adults with Aphasia

A Systematic Review

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Abstract

Access to skilled speech and language intervention can be difficult for individuals residing in rural areas as well as for individuals with complex health and mobility issues. Telehealth (which includes therapy and rehabilitation) can provide effective services in the context of one's home, allowing clinicians to reach a wider population of individuals.

Purpose: The objective of this systematic review was to determine whether tele-practice service delivery produces positive expressive language outcomes that are comparative to direct service delivery for adults with aphasia

Method: A variety of databases were searched utilizing systematic inclusionary and exclusionary criteria. This review focused on adults over the age of 18 with a formal diagnosis of aphasia who engaged in telehealth intervention. Various research designs were identified and analyzed and identified articles included a total of 235 participants.

Results: The identified studies supported the implementation of tele-practice as a means of providing individuals with aphasia access to services that produce positive expressive language outcomes. Several studies indicated that tele-practice produces similar outcomes when compared to traditional direct service therapy. Several studies also included qualitative data relating to patient satisfaction and quality of life, many of which produced positive outcomes.

Conclusion: When assessing the overall results of the chosen studies, they were found to largely support the inclusion of tele-practice as an effective option for producing positive expressive language outcomes for individuals with aphasia. Identified potential study limitations include variability in treatment times and treatment programs, assessment tools used, clinical training of individuals providing treatment, small sample sizes, and variable patient characteristics (severity, time post-onset, etc). Future research should focus on implementing research designs using larger numbers of individuals to increase generalizability.

Aphasia is an acquired neuropathology that can be caused by a number of different conditions that affect the brain. The leading cause of aphasia in adults is acute in nature, including stroke and the aftermath of head injury, though aphasia may also display a gradual onset due to brain tumors and other diseases including toxemia, infection, or abscesses (Brookshire, 2015). Aphasia disrupts an individual's ability to speak, comprehend and/or produce language which ultimately compromises their ability to communicate effectively.

According to the National Aphasia Association (NAA), about ⅓ of strokes result in aphasia, and there are at least 2,000,000 people with aphasia currently in the United States, with the most affected population being older adults (n.d.). The NAA also stipulates that, by 2020, the number of individuals diagnosed with aphasia will rise to 180,000 yearly. As the population of individuals with aphasia grows, the need for skilled intervention provided by speech and language pathologists will increase exponentially. Per the American Speech-Hearing-Language Association, speech-language pathologists (SLP) play a crucial role in diagnosing aphasia, with further responsibilities including developing and implementing evidence-based plans and facilitating each individual's access to comprehensive services (ASHA, n.d.a).

Hospital stays post stroke have decreased drastically over the years, subsequently decreasing an individual's access to rehabilitation services and placing a larger burden on the individual and their caregivers, many of which are unprepared for the role they will have to play in their loved one's recovery (Lutz, Young, Cox, Martz, & Creasy, 2011). For some individuals, accessing skilled intervention services can be the most difficult aspect of recovery; this difficulty may be due to location (rural and remote areas), lack of speciality services, lack of access to transportation, medical fragility (inability to travel due to medical issues), financial limitations or other familial obligations (Dew et al., 2012). These barriers prevent individuals from receiving

services that are a crucial component to their rehabilitation, and, as Dobkin confirmed in a 2005 study, positive treatment outcomes are correlated with receiving high quality professional intervention within the first 3-12 months after stroke occurs.

One of the methods by which clinicians have attempted to facilitate access to intervention for all individuals has been through the implementation of tele-practice, a term which is encompassed under the broad heading of "telehealth". The Health Resources and Services Administration (HRSA) defines telehealth as "the use of electronic information and telecommunication technologies to support and promote long-distance clinical healthcare" (2017). The American Speech-Language-Hearing Association prefers the term tele-practice as it implies that these services may exist beyond the healthcare setting, and defines it as "the application of telecommunications technology to the delivery of speech-language pathology and audiology professional services at a distance" (n.d.). Initially, this practice included professional emails, use of the internet, and confidential databases for sharing electronic information. Over the last decade, these services have expanded to include video-conferencing (similar to Skype ™), media streaming, and file transferring. It is important to note that teletherapy involves live access to a trained clinician that occurs in real-time, and tele-rehabilitation includes services and activities that do not require the direct involvement of the SLP. The underlying purpose of all of these technologies has been to connect the clinician with the client for the purpose assessment and intervention.

Speech-language pathologists can identify the potential benefits of this type of service delivery model for persons with aphasia (PWA) based on the research that currently exists, which highlights the need for intense, frequent treatment as quickly as possible post-onset (Dobkin, 2015, Bhogel, Teasell, & Speechley, 2003). This form of service delivery may be a

cost effective way to extend the reach of therapy services while maintaining or increasing the intensity of intervention.

If a clinician chooses to implement an alternative form of service delivery such as tele-practice, it is critical that the quality of the services provided be equal to that which the client could receive during traditional intervention. Ensuring this equity exists before planning a course of treatment is essential in ensuring all individuals have access to high-quality evidence-based services. Given the variety of intervention programs available and the ability to implement these programs via video-conferencing, the purpose of this systematic review is to determine if tele-practice services produce positive expressive language outcomes and whether those outcomes are comparative to live, face-to-face therapy.

Methodology

For this review, the researchers conducted a systematic search of publications in OVID Medline, CINAHL, PubMed, and Psycinfo in November, 2017. Two main topics were combined in each search, aphasia, and telehealth. Table 1 contains the 11 search terms used across all databases. Table 2 contains a sample search conducted on Ovid Medline.

Two reviewers independently screened titles and abstracts against inclusionary and exclusionary criteria. Table 3 contains the inclusionary and exclusionary criteria used when screening articles. If the abstract was not sufficient for determining eligibility, full text articles were obtained and reviewed. Any differences in opinion regarding eligibility were discussed and articles were referred to the final group member in order to reach consensus.

Quality assessment was conducted using the form found in Appendix 1. Each researcher reviewed articles independently, using criteria specific to the study type. One point was awarded for each criterion met on a pass fail basis. Criterion varied across studies from 4 to 8, and all

quality assessments were reviewed by the group as a whole. Through discussion, a consensus was reached and all quality levels are recorded in Table 4. Using this assessment, each study was awarded a quality level of low, moderate or high. Studies with a high quality level met 70% or more of design-specific criteria, studies with a moderate quality level met from 40%-69% of design-specific criteria with no "fatal flaws", and studies with a low quality level met less than 40% of design-specific criteria or had at least one "fatal flaw". Each study was also awarded a level of evidence based on the type of study. Level I indicates systematic reviews, meta-analyses, and randomized controlled trials, level II indicates two groups, and non-randomized studies, level III indicates one group, and nonrandomized studies, level IV indicates descriptive studies that include outcome analysis, and level V indicates case reports and expert opinion. Evidence levels for each study can be found in Table 4.

After quality assessments were conducted, each researcher extracted data from a list of assigned articles. This data is compiled in Table 5. When discrepancies occurred, the article was reviewed by a second researcher after which discussion was held to reach consensus.

Results

Overall, 130 references were retrieved from manual searching (20) as well as from the following databases: Ovid MEDLINE (34), CINAHL (24), Psychinfo (28), and Pubmed (24). 75 studies were left after duplicates were removed. After reviewing the abstracts and titles of these studies, 30 were excluded, with an additional 12 removed due to publication dates outside of the inclusionary criteria. 33 articles were then assessed and an additional 15 were excluded, 12 due to the nature of the outcome measure, and 3 due to coexisting treatment delivery models. 18 total studies were included in this Systematic Review. See Figure one for full details.

The 18 studies included within this review included a total of 235 participants. Study design included 10 single case AB design studies, 4 one-group pretest-posttest design studies, and 4 small randomized control trials. Quality of evidence ranged mostly from moderate to high across all studies, with one study being assessed as low. All studies included adults over the age of 18.

When analyzing the results of the identified studies, several concluded that there were statistically significant results, however outcome measures varied across studies. The majority of studies containing statistically significant results used the Western Aphasia Battery Aphasia Quotient as the primary outcome measure. These studies were conducted by Agostini et al. (2014), Archibald, Orange & Jamieson (2009), Cherney et al. (2011), Choi, Park & Paik (2016), Fridler et al. (2012), Macoir, Sauvageau, Boissy, Tousignant, & Tousignant (2017), Meyer, Getz, Brennan, Hu, & Friedman (2016), Palmer et al. (2012), Pitt, Theodoros, Hill, & Russell (2017), Steele, Baird, Mccall & Haynes (2015) and Woolf et al. (2016).

Several studies did not find statistically significant changes, but produced positive outcomes that were trending towards statistical significance. These studies were conducted by Cherney, L.R., (2010), Cherney, Halper, Holland, & Cole (2008), Dechene et al. (2011), Furnas, & Edmonds (2014), Pitt, Theodoros, Hill, Rodriguez, & Russell (2017), Rogalski et al. (2016) and Ruiter, Rietveld, Hoskam & Van Beers (2016).

Of the 18 identified studies, five contained control groups that enabled a direct comparison between tele-practice service delivery and face-to-face service delivery. These studies were conducted by Agostini et al. (2014), Cherney, L.R., (2010), Meyer, Getz, Brennan, Hu, & Friedman (2016), Fridler et al. (2012) and Woolf et al. (2016). All five studies concluded that the differences in outcomes between the two groups were not statistically significant,

indicating that tele-practice service delivery may produce similar expressive language outcomes when compared to face-to-face service delivery. One study noted that, upon comparison, tele-practice produced greater positive outcomes than the control.

Discussion

The efficacy of tele-practice service delivery as a stand-alone treatment and when compared to face-to-face service delivery has been supported by multiple studies described in this review. However, it should be noted that there are several limitations that need to be addressed when considering the application of this technology. In their practice portal regarding the use of tele-practice, ASHA identifies a list of key issues regarding client selection that may potentially impact a clinician's ability to implement tele-practice services. These include physical and sensory issues (e.g., hearing and vision deficits, positioning, fine motor skills), cognitive and behavioral characteristics (e.g., cognition, attention, engagement, following directions), communication deficits/differences (e.g., auditory comprehension, intelligibility, literacy, cultural differences, language barriers), and access to support resources such as high quality equipment, a suitable internet connection, a conducive environment, and an adequate knowledge base in regards to technology (n.d.b).

Further factors that need to be considered include reimbursement through private insurance and Medicare/Medicaid, protecting confidentiality and upholding the Health Insurance Portability and Accountability Act (HIPPA), and identifying and obtaining state specific licensure requirements and policies regarding tele-practice (ASHA, n.d.b). When considering the method of delivery, teletherapy (services delivered in real-time via technology) may be the only model that can be billed by the SLP, while tele-rehabilitation (activities completed by the individual without the live presence of the SLP), may not be billable as the SLP is not present,

virtually or otherwise. These factors all present barriers to the application of this method of service delivery, and, as stated by Janet Brown, Director of Health Care Services in Speech-Language Pathology at ASHA, "SLP has a decade-long track record in terms of association support, research, and member interest, but unfortunately, only a small group of clinicians currently have the opportunity to use tele-practice." (2010).

Further research is needed to address the feasibility and possible financial benefits of funding tele-practice as well as the inclusion of targeted, high powered studies which control for patient characteristics and directly compare tele-practice outcomes to those received through face-to-face intervention.

Conclusion

This systematic review looked at the efficacy of tele-practice on expressive language outcomes for adults with aphasia. The studies analyzed in this review showed that a tele-practice method of service delivery yielded positive expressive language outcomes, with the majority of studies reaching the level of statistical significance (11 total). 5 studies provided evidence indicating that similar language-based outcomes were received through tele-practice when compared to traditional face-to-face service delivery. Due to the limitations in population sizes, varying outcome measures which were at times unstandardized, and highly variable client demographics, more evidence is needed in this area to verify and generalize these findings.

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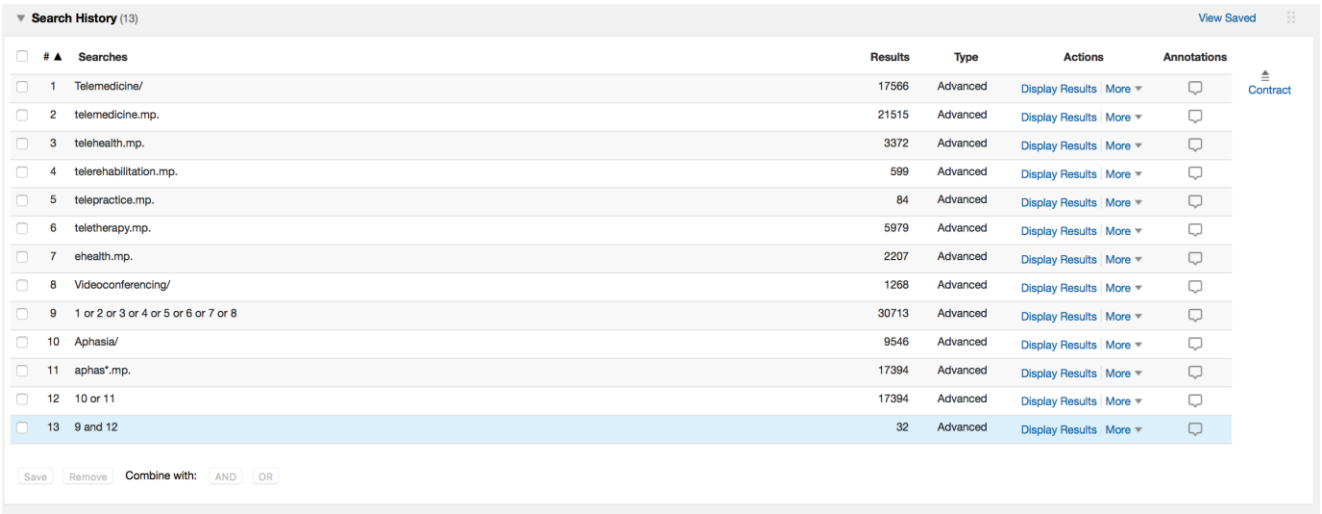
Table 1: *Search Terms*

Aphasia	Telehealth
Broca's Aphasia	Tele-rehabilitation
Primary Progressive Aphasia	Tele-practice
Dysaphasia	Telemedicine
	Teletherapy
	E-Health
	Videoconferencing

Table 2: *Sample of a Complete Search Strategy*

Database searched: Ovid Medline
Date that search was conducted: November 8, 2017
Subject headings: Aphasia & telemedicine
Keywords used: Aphasi***,** ehealth, or telehealth or telemedicine or tele-practice or tele-rehabilitation or teletherapy or videoconferencing



Search history (including the combination of terms and Boolean operators used):

Table 3: *Inclusionary and Exclusionary Criteria*

	Inclusionary	**Exclusionary**
Population	Adults 18+ Formal diagnosis of aphasia	Individuals less than 18 years of age Individuals with concomitant language impairment not associated with aphasia
Intervention	Telehealth service delivery Treatment	Combination telehealth and face-to-face service delivery Assessment
Comparison	Control group comparison Therapy using face-to-face service delivery model	Combination telehealth and face-to-face service delivery
Outcome	Outcomes related to expressive language	Outcomes focused on reading comprehension, written output, or social/emotional changes
Study Type	Published in the last 10 years Published in peer-reviewed journal Written in English	Not published in the last 10 years Non-peer reviewed publication Non-English publications

Table 4: *Quality of Evidence*

		Criteria of Quality											
Study	**Type of Design**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Quality Level**	**Evidence Level**
S1	7	1	1	1	1	0	1	0	1	-	-	6 High	LIV
S2	7	1	1	1		0	1	0	1	-	-	6 High	LIV
S3	7	1	1	1	1	1	0	0	1	-	-	6 High	LIV
S4	6	0	1	0	0	1	1	1	1	-	-	5 Moderate	LIII

S5	3	1		1	1		1	0	1	1	1	8 High	LI
S6	7	1	1	1	1		1	0	1	-	-	6 High	LIV
S7	7	1	1	1	1		1	0	1	-	-	7 High	LIV
S8	3	1		1	1		1	0	1	1	0	8 High	LI
S9	6	0	1	0	0	1	0	1	1	-	-	4 Moderate	LIII
S10	7	1	1	1	1	1	0	0	0	-	-	5 Moderate	LIV
S11	7	1	1	1	1	1	1	0	1	-	-	7 High	LIV
S12	6	0	1	0	1	1	1	1	1	-	-	6 High	LIII
S13	3	1	0	1	1	1	1	0	1	1	0	7 High	LI
S14	7	1	1	1	1	0	1	0	1	-	-	6 High	LIV
S15	7	0	1	1	1	0	1	0	1	-	-	5 Moderate	LIV
S16	6	1	1	0	0	1	1	1	1	-	-	6 High	LIII
S17	3	1	0	1	1	1	1	0	1	1	1	8 High	LI
S18	7	1	1	0	0	0	0	0	1	-	-	3 Low	LIV

Table 5: *Summary of Identified Studies*

Study	Design Type	Quality Assessment	Population	Intervention(s)	Outcome (s)	Measurement(s)	Summary Description	Statistical Significance
S1: Macoir et. al (2017) *Original Research: In Home Synchronous Telespeech Therapy to Improve Functional Communication in Chronic Postroke Aphasia: Results from a Quasi-Experimental Study*	Single-case AB design	LIV High quality	20 adult participants (Age range = 47-78 years old) Inclusion Criteria: - Chronic aphasia (secondary to a first and unique left hemisphere stroke) - 1 year post stroke - Moderate to severe anomia - Caregiver needed to be available	A tele-rehabilitation platform and software (Oralys teleTherapy), based of the Promoting Aphasics Communicative Effectiveness (PACE) approach 3 weeks (9 therapy sessions with 3 sessions per week)	1) PACE Communication effectiveness score 2) Communication exchange duration 3) Variety of strategies used 4) Number of communication acts	$p < 0.01$ There was an increase in communicative effectiveness ($p=0.00043$) a decrease in communication exchange duration (because communication was faster and more efficient) ($p=0.0009$), a decrease in communication acts (less information was needed to be understood) ($p=0.0006$) and an increase in the number of communication strategies used ($p=0.0007$).	"Very early stage" p. (637) More information should be done, but proved effective in all categories. "This study is the first tos how that the PACE approach is also suitable for telespeech therapy…" (p. 636).	Aphasia treatment delivered through videoconferencing resulted in improvements in functional communication effectiveness.
S2: Choi, Y. Park, H,. Paik, N., (2016). *A Tele-rehabilitation Approach for Chronic Aphasia Following Stroke*	Single-case AB design	LIV High quality	8 adult participants (4 female/4 male) (Age range = 37-62 years old) Recruited from an outpatient rehabilitation clinic in a university hospital Mean time since stroke = 30 mons (2-90 months) Inclusion: - Diagnosed with exhibiting post stroke (chronic) aphasia by a licensed professional	Telespeech therapy program iAphasia (developed for the iPad) The program had 6 therapeutic domains: auditory comprehension, reading comprehension, repetition naming, writing and verbal fluency. Each domain had 6 levels of difficulty	1) An initial screening test (the Korean version of the shortened Frenchay Aphasia Screening Test 2)Korean version of the Western aphasia Battery (K-WAB) was administered before and after 3) Questionnaire (for user satisfaction)	Mean K-WAB AQ (percentile) scores significantly improved from baseline ($p=0.025$). Program usage over time correlated strongly with the improvement seen in the K-WAB scores ($p=0.006$)	The development of a mobile app device has the efficacy to reach patients in remote locations for aphasia therapy. More long term follow up evaluation is needed to confirm the effectiveness and sustainability. Future studies should try to use a more homogenous cohort.	"Could be a feasible and effective treatment method for chronic aphasia patients" (p. 439). "Our data support that the development of iAphasia as a mobile device app with therapeutic utility has the potential to reach underserved or neglected populations of patients with postroke aphasia" (p. 438).
S3: Dechene et al. (2011) *Simulated In-Home Tele Treatment for Anomia*	Single-case AB design	LIV High quality	3 participants (65+ years old) Recruited from the Health and Social Services Center, University of Institute of geriatrics of Sherbrooke Inclusion: - Oral expression difficulties - Exhibit oral receptive level sufficient to participate in remote treatment - Demonstrate minum skills in	12 speech therapy tele treatments (2 sessions a week for 6 weeks) Each treatment session: - Pre-assessment of trained stimuli (for baseline data) - 3 different lexical tasks involving stimuli - Specific circumlocutions training - Post-assessment of trained stimuli All training was	1) Pre/post assessment 2) Satisfaction questionnaire	Clinical outcomes improved for all three participants	Results indicate teletreatment is effective in the rehabilitation of anomia post-stroke Some decline noted attributed potentially to outside issues (i.e., health status and corresponding state of mind). Need for longer follow-up to assess maintenance.	"These elderly patients appeared to accept this new service delivery method, even more than therapists, according to the results of other studies" (p. 8).

			implementing oral tasks	delivered by the same SLP (there were 2 total)				
S4: Steele R.,, Baird A., McCall D., Haynes L. (2014) *Combining Teletherapy and On-line Language Exercises in the Treatment of Chronic Aphasia: An Outcome Study*	Outcome study	LIII Moderate quality	9 participants 44-77 years old Enrolled Snyder Center for Aphasia Life Enhancement <u>Inclusion</u>: - Adults diagnosed with long term chronic aphasia - Willingness to participate - Internet connectivity at home	12 weeks (divided into 3 periods of 4 weeks each) 3 hours of individual sessions done remotely + 18 hours of group therapy For a total of 21 hours of remote therapy WebEx and goToMeeting therapy services were used	1) Western Aphasia Battery (WAB) p <.10 2) Communicative Effectiveness Index (CETI) 3) Asha Noms (NOMS): motor-speech performance, speaking, listening, reading & writing 4) Communication Confidence Rating Scale for Aphasia (CCRSA-RIC)	Spontaneous speech +0.9 p = .18 Auditory Verbal Comprehension -1.9 p =.55 Repetition +5.9 p =.102 Naming +3.7 p =.25 Aphasia Quotient +3.5 p=.057 Speaking (p <.05) +0.6 p =.006	"Independent work increased with time,and use satisfaction following participation was high"	Trending towards clinical significance
S5: Palmer, R., et al. (2012) *Computer Therapy Compared with Usual Care for People with Long-Standing Aphasia Post-stroke: A Pilot Randomized Control Trial*	Randomized Control Trial (RCT) Single blinding Parallel group	LI High quality	34 participants 17 baseline 15 - 5 mon. 13 - 8 mon. Control 17 baseline 15 - 5 mon. 11 - 8 mon. Participants were obtained from local support groups and speech and language therapy department records <u>Inclusion</u>: - Diagnosis of stroke and aphasia with word finding difficulties - Were able to repeat spoken words from an SLP	Step-by-step computer program - 20 minutes, 3 days a week for a 5 month intervention period	1) Clinical effectiveness: Including recruitment rate, completion rates and statistical variability 2) Object and Action Naming Battery (at 5 and 8 mons.)	5 mons. 19.8% increase - words named (p = 0.014) 8 mons. 11.3% increase - words named (p =0.221)	"Self-managed computer therapy for aphasia is feasible and that it will be practical to recruit sufficient participants to conduct an appropriately powered clinical trial…" (p. 1).	5 months yes (p < .05) 8 months no (p≮ .05) "Potentially clinically and cost-effective and that it is feasible to conduct a large randomized control trial to provide robust evidence…" (p.7).
S6: Meyer, A., et al. (2016) *Tele-rehabilitation of Anomia in Primary Progressive Aphasia*	Single-case AB design	LIV High quality	14 participants 3 participants completed remote treatment PPA	6 months (In the first month - 2 sessions per week and during the 5 month period following - shorter sessions occurred 3x a week). Language and cognitive tests were administered (MSSE, MoCA and NAT). Phonological treatment (PTC) Orthographic treatment (OTC).	1) Remote: Change in naming accuracy (CNA)	Binomial testing comparing pre/post-treatment accuracy. Chi-square to compare post-test accuracy in treatment condition to post-test accuracy in untrained condition.	Subject 1: When comparing untrained condition (UC) to phonological treatment condition (PTC), # of items named correctly was statistically significant (p=.004) Subject 2: PTC oral naming accuracy post-treatment significantly greater (p=.011). Subject 3: No significant differences on remediation items (though significant oral naming accuracy increase on prophylaxis items comparing PTC to	When compared to in-person participants w/ same PPA subtype, telerehab participants showed effects within the expected range or larger. All participants showed positive treatment effects.

							UC).	
S7: Furnas, D., & Edmonds, L. (2014) *The Effect of Computerised Verb Network Strengthening Treatment on Lexical Retrieval in Aphasia*	Single-case AB design	LIV High quality	2 participants (Ages 54 & 55) Inclusion: - Aphasia resulting from a single, left-hemisphere stroke occurring at least 9 months prior - No history of other neurological or learning disabilities - Native english speaking - No more than moderate-to severe apraxia of speech	3 times per week for 2 hours 24 sessions of treatment over 8 weeks Probe pictures and VNeST-C Program (over the computer)	1) Western Aphasia Battery (WAB) 2) Aphasia Quotient (AQ) portion of the WAB-R - Reading and writing sections from part 2	Patient 1: improvement on the WAB-R ; clinically significant increase in AQ Patient 2: no change on WAB-AQ	Results showed improvements in lexical retrieval (during sentence production) of stimuli. Additional improvements were observed.	The results suggest that the VNeST-c program/protocol have promise in generalized treatment for adults with aphasia (need for refinements). Since there was limited improvement in "untrained verbs", protocol needs to be modified to promote generalization
S8: Cherney, L.. Babbitt, E., Kim, K., Hurwitz, R., Ngampatipatpong, N., & van Vuuren, S. (2011) *Aphasia Treatment over the Internet: A Randomized Placebo-Controlled Clinical Trial*	Randomized placebo-controlled trial	LI High	32 individuals with chronic aphasia following a single left-hemisphere stroke occurring more than 6 months previously One group receiving web based ORLA treatment and one group using a commercial, off the shelf computer program	Oral Reading for Language in Aphasia – ORLA administered over the internet 9 hours of treatment a week for 6 weeks (3x30 minutes/day or 2x45 minutes/day, 6 days a week)	1) Western Aphasia Battery - Revised -Aphasia Quotient scores (WAB-R AQ) 2) Reading and writing subtest scores (WAB-R reading, WAB-R writing)	Pre and post treatment and at a 6 week follow-up Scores compared using a two-sided paired t-test	Pre-post treatment improvements within intervention group: Significant at the 0.05 level for the WAB-R AQ - after 6 weeks of treatment, there was a statistically significant increase in language performance Pre-post treatment improvements when compared to placebo group: Not significant at the 0.05 level for WAB-R AQ, WAB-R reading or WAB-R writing, after 6 weeks of treatment the difference in performance between groups was not significant enough to draw conclusions.	Web based ORLA language therapy may be an effective form of service delivery for increasing expressive language in adults with aphasia post-stroke
S9: Archibald, L.M., Orange, J.B., & Jamieson, D.J. (2009). *Implementation of computer-based language therapy inaphasia.*	Pilot study - one group pretest-posttest design	LIII Moderate	10 participants with aphasia resulting from a single vascular stroke to the left hemisphere. At least 6 months post-stroke. 2 participants dropped out/passed away during the study	Treatment completed through AphasiaMate Software for at least 1 hour/week for 15 weeks. Progress was reviewed every 2 weeks. Modules included auditory processing, visual matching, reading comprehension, spelling, semantics, sentence processing, time and money	**1)** Western Aphasia Battery (WAB) 2) Communicative Effectiveness Index (CETI) 3) Functional Assessment of Communication Skills for Adults (FACS)	WAB scores post-treatment: 1) Auditory comprehension: p=0.03 2) Naming: p=0.046 3) Spontaneous Speech: p=0.086	Significant improvement was shown on the measures of auditory comprehension. Improvement was shown in naming, spontaneous speech and overall communication. There was more improvement in participants with moderate-severe aphasia.	AphasiaMate software has the ability to provide adequate therapy activities within specific areas - may prevent the need to design individual programs for each separate rehab goal
S10: Agostini, M., Garzon, M., Benavides-Varela, S., De Pellegrin, S., Bencini, G., Rossi, G.,... Tonin, P.(2014)	Single case study (AB design)	LIV Moderate	5 participant. - Single left ischemic stroke and aphasic disturbances persistent from 2 years or more - Anomic deficits - Good	All participants carried out the same naming treatment face-to-face and through teletherapy - some began with each so it was balanced out. 8 sessions of equal duration were	1) Naming accuracy was measured - a standardized measurement tool was not used. It was measured at baseline, immediately	Patients performed significantly better immediately after treatment than at baseline (p<.01). There was no effect of treatment type (p=0.844).	Time (baseline, immediately after treatment and 3 weeks after treatment) had more of an effect than the type of treatment.	The treatment of naming deficits during face-to-face therapy and teletherapy had comparable outcomes, meaning teletherapy may be a feasible way to deliver therapy to those in remote locations.

Tele-rehabilitation in poststroke anomia.			comprehension - No neuropsychological deficits.	completed. There was a three week break after the first type of therapy.	after therapy and three weeks later.			
S11: Pitt, et. al. (2017) *The Development and Feasibility of an Online Aphasia Group Intervention and Networking Program - TeleGAIN*	Pilot trial Test-retest	LIV High	4 participants with non-fluent aphasia who were at least 12 months post-onset.	3 participants accessed therapy from the internett in their own homes and one used a computer and internet connection at the University. Participants participated in twelve week treatment	1) Technical feasibility 2) Language function was assessed using the Comprehensive Aphasia Test (CAT). 3) Communication-related quality of life using the Assessment for Living with Aphasia (ALA) 4) Participant satisfaction	Deemed successful in delivery of therapy based on participation and clinician report. 'The delivery of a 12-week aphasia group treatment via tele-rehabilitation (TeleGAIN) was feasible and acceptable to participants (p.9)." - Participation rate was 93.8%. "P1, P2, and P4 demonstrated a significant improvement on the subtests of Naming and Spoken Picture Description, Spoken Comprehension and Written Comprehension respectively of the CAT… differences in scores demonstrated 'significant' (p.9). "Participant satisfaction was high and all participants respondd in the positive range for the majority of questions (p. 9)."	The author concluded that the framework used (MRC framework) in the intervention was successful and there were "positive trends towards improvement in language functioning and communication related quality of life for participants… (p.12)."	'The outcomes for four participants suggest that TeleGAIN may yield some improvements in communication-related quality of life and language functioning (p.9)"
S12: Fridler, N., Rosen, K., Menahemi-Falkov, M., Herzberg, O., Lev, A., Kaplan, D., … Shani, M. (2012). *Tele-rehabilitation therapy vs. face-to-face therapy for aphasic patients.*	Within subject case study design (ABAC/ACAB)	LIII High	Eight native Hebrew speaking participants with aphasia (Five with Anomic Aphasia, two with Conduction Aphasia and one with Broca's). All participants between ages 46-72 with a left CVA.	At the start of the session series, a naming task was completed. 20 incorrectly named pictures were identified for each patient and split into groups of 10. One set was for training and the other for assessing generalization. Each session was 45 minutes and began with spontaneous conversation followed by the naming of the 10 words. Other language activities were chosen based on the client's goals and needs. This structure was used for both types of therapy.	1) Western Aphasia Battery (oral language) (WAB)	The difference between improvement in Aphasia Quotient following telerehab and following face-to-face was significant (p=0.035) Telerehab led to a greater improvement in the Aphasia Quotient than face-to-face therapy" (p=0.04)	The author concluded that aphasia therapy via tele-rehabilitation yields similar results to face-to-face therapy. They concluded that technology can be effectively used for therapy and could be beneficial for those in rural areas or those who have mobility difficulties	The results showed that the outcomes from telerehab were statistically significant, which means that telerehab is an effective form of therapy.
S:13 Cherney, L. (2010)	Small (n<100) RCT	LI High	25 total 16 males 9 females	24 hour-long sessions of ORLA in the clinic, 2-3	1) Western Aphasia Battery including the	Mean change in WAB-AQ test scores from pre- to post	Low-intensity computer delivered ORLA provided to	For clinical significance, a 5-point change on the WAB-

Oral Reading for Language in Aphasia (ORLA): Evaluating the efficacy of computer-delivered therapy in chronic nonfluent aphasia	Pretest-Posttest Control Group Design		Chronic nonfluent aphasia as a result of a single LCVA 12+ months post onset Ages 35-81 (average 56 & 61 in both groups)	times a week. For computer based participants, an assistant did set up and left them while they used the computer. An SLP provided intervention for the other group (not the same SLP who conducted assessments).	WAB-AQ (Aphasia Quotient)	treatment was 3.29: d = 0.74 (medium effect size when comparing no treatment to treatment phases) All but 1 made large changes with computer ORLA on at least 1 outcome measure: Effect sizes for discourse measures were large for words per minute (d = 0.81) and medium for CIUs (correct information units) per minute (d = 0.47) No significant differences found on any outcome measures comparing computer based ORLA and SLP delivered ORLA: p=.2-.6	individuals with chronic nonfluent aphasia, can be efficacious and may be equivalent to SLP delivered ORLA.	AQ is considered to be important, so this study did not reach that (average change of 3.29 points), though 4 of the 11 participants had more than a 5 point change, so it's encouraging data.
S14: Cherney, L. R., Halper, A. S., Holland, A. L., & Cole, R. (2008). *Computerized Script Training for Aphasia: Preliminary Results*	Single-case AB design	LIV High	3 subjects with chronic aphasia due to LCVA at least 6 months prior. - Age & sex: 65F, 78M, 65F - No comorbid diagnoses. - Literate with at least 12th grade education. - Good vision and hearing.	4 weeks of weekly hour long sessions to develop the scripts to be used (SLP & client) which are approved as meaningful and applicable by the client and then recorded by the SLP on a laptop. Baseline testing completed with a 1 hour training regarding computer use. Client asked to complete 30 minutes per day of script training at home, 3 weeks per script (9 weeks total), during which there are weekly clinic visits where the SLP observes their practice.	1) Western Aphasia Battery (WAB-AQ) 2) Communication Activities of Daily Living (CADL-2) 3) Quality of Communication Life Scale (QCL) 4) Scoring by authors and outside SLPs	WAB-AQ score increase of >5 points for 2 subjects, 1 decreased: >5 points is deemed "beyond the standard error of measurement for the WAB" CADL-2: No notable changes QCL: One patient displayed positive changes – not statistically verified Script Performance: Improvements seen for all measures on all three scripts for each participant	Script training is a potentially effective intervention for people with fluent and nonfluent aphasia, positive changes may occur regardless of method of practice (computer vs. therapist-presented). Script training may have beneficial effects on linguistic skills as evidenced by all 3 patients increased WAB-AQ scores.	Given the size of the study these findings cannot be deemed clinically significant yet. They do however provide evidence that computerized training may be as effective as face-to-face therapy.
S15: Pitt, R., Theodoros, D., Hill, A. J., Rodriguez, A. D., & Russell, T. (2017). *The feasibility of delivering constraint-induced language therapy via the Internet*	Single-case AB design	LIV Moderate	2 subjects with chronic acquired aphasia due to ischemic stroke. 23 & 24 months post-onset. Age & sex: 41M, 78F	Both treated concurrently by one SLP via the Internet with access to three hours of therapy per day, five days per week for two weeks. iCILT maintained principles of CILT The CILT procedure is similar to Go Fish and the client must request a card from the opponent, with the clinician providing appropriate cues.	1) Comprehensive Aphasia Test (CAT) 2) Assessment for Living with Aphasia (ALA)	CAT: Clinically significant differences on only 2/8 subtests (written comprehension and naming) for one subject: determined using CAT manual test-retest minimum change ALA: Treatment didn't create positive changes to communication-related QOL for either subject	"This study demonstrated that the delivery of an intensive aphasia treatment via tele-rehabilitation (iCILT) was feasible and viewed favorably by recipients. The results from these two case studies suggested that iCILT yielded some improvements in language functioning although it did not result in changes in communication-related QOL" (p. 7)	Using the CAT manual, there were clinically significant results in 2 areas for one subject, no analysis done between subjects.

				The difference in standardized T-scores from baseline to post-treatment was calculated				
S16: Rogalkshi et. al *Communication Bridge: A pilot feasibility study of Internet-based speech-language therapy for individuals with progressive aphasia*	A pilot feasibility study	LIII High	34 participants (31 completed the study), with a diagnosis of dementia due to neurogenerative disease, with prominent aphasia symptoms.	1 hour, internet video-conferencing treatment sessions with an ALP. Regimen included impairment based approaches, activities and/or participation based approaches, ongoing education on disease and counseling/support. Additional home exercises were also apart of the intervention.	1) American Speech-Language Hearing Association and functional communication measures (ASHA-FCM) & Communication Confidence Rating Scales for Aphasia (CCRSA) 2) Western Aphasia Battery Revised (WAB-R-AQ), Mini Mental State Examination; PPA (MMSE) & Boston Naming Test (BNT) 3) Semi-structured post-therapy interview	"All participants maintained or improved their level of functioning in their most challenging domain… ($p < .4$) (p.217)." "A repeated-measure ANOVA showed significant change in CCRSA scores across three evaluations ($p.<0.02$) (p. 217)." "Participant, care partner, and therapist feedback were overwhelmingly positive… therapy exceeded expectations (p. 217)."	"Data from this study suggest Internet-based SLT using person-centered impairment directed and activity and/or participation-based interventions and disease education provides a feasible method for improving access to care for individuals with mild and/or moderate aphasia symptoms who have an engaged care-partener and prior familiarity with a computer (p. 220)."	The clinical significance of the results from each outcome measure "showed significant change in CCRSA scores across three evaluation (p. 217)." Additionally, many of the participants report seeing improvements, which has shown in their maintenance or improvement across different assessments.
S17: Woolfe et, al. (2016) *A comparison of remote therapy, face to face therapy and an attention control intervention for people with aphasia: a quasi-randomised controlled feasibility study*	A quasi randomized controlled feasibility study	L1 High	21 participants. At least 6 months post a left hemisphere stroke, presented with word finding difficulties due to aphasia, no signs of visual neglect, no hearing loss greater than 40 dB, no secondary neurological diagnosis and were not receiving services elsewhere.	4 interventions groups were being compared: (1) Remote therapy delivered from a University lab - 8, 1 hour sessions 2x a week. (2) Remote therapy delivered from a clinical site - Dissentered via FaceTime using Ipad (8, 1 hour sessions 2x a week). (3) Face to face therapy - 2x a week for 8 individual sessions (4) An attention control condition - 8 remote conversation sessions delivered over internet using FaceTime.	1) Test of spoken picture naming. 2) Assessment of conversation (POWERS procedure). 3) Observations and interviews with the participants.	"Both main effects were significant [time and group]... and there was significant interaction ($p<0.001$) (p. 366)." "Pairwise comparisons showed no difference between week 1 and week 4 or between week 8 and week 14, but highly significant differences between week 4 and week 8 and week 45 and week 14 ($p<0.001$) (p. 366)." Using a 3-point scale (accompanied by a happy, neutral or sad face), all but 1 of the participants selected 'good' and the happy face.	"This study demonstrates that delivery of remote word finding therapy for people with aphasias, using mainstream video conferencing technology, is feasible (p. 367)."	The change in the outcome measures (over time and group) proves significant with scores improving and participant satisfaction at a high. Additionally, all participants showed significant individual gains also.
S18: Ruiter, M.B., Rietveld, T.C., Hoskam, V., & Van Beers, M. (2016). *An exploratory*	Single Case design (AB)	LIV Low	1 participant. - Age 71, right handed, 7 months post onset of left middle cerebral artery infarct. Diagnosed with	E-REST included 525 therapy items, divided into ten different levels. Both the SLP and the participant were engaged in e-REST, although not	1) A picture Description Task (PDT) was administered to analyze: Grammatical Output, Verbal Effectiveness,	Percentage of Words produced in Ellipses: parameter %WIE - ($p=0.000$) Percentage of Essential Content Units (ECUs) ($p =$	The authors state that e-REST has potential to enhance communication in those who have chronic aphasia (in Dutch).	Although the results were positive for e-Rest, it should be interpreted with caution, as it only included one participant and did not provide in depth

investigation of E-Rest: Teletherapy for chronically aphasic speakers.			Broca's aphasia (average severity)	necessarily at the same time, as e-REST had the ability to upload audio files.	and Verbal Efficiency	0.000) Number of Essential Content Units per Minute (ECU/min) (p = 0.000)		information about the fidelity of intervention and reliability/validity.

Appendix 1: Method for Assessing Quality of Evidence

Quality Criteria:

Randomized Control Trials

1. Was the assignment to the treatment groups really random?
   - Computer-generated random numbers
   - Random numbers tables
2. Was the treatment allocation concealed?
   - Adequate approaches to concealment of randomization
   - Centralized or pharmacy-controlled randomization
   - Serially-numbered identical containers
   - On-site computer based system with a randomization sequence that is not readable until allocation
   - Other approaches with robust methods to prevent foreknowledge of the allocation sequence to clinicians and patients
   - Inadequate approaches to concealment of randomization
   - Use of alternation, case record numbers, birth dates or week days
   - Open random numbers lists
   - Serially numbered envelopes (even sealed opaque envelopes can be subject to manipulation)
3. Were the groups similar at baseline on key characteristics? (selection/confounding bias)
4. Were the eligibility criteria specified and were they logical in terms of the intervention under study?
5. Were outcome assessors blinded to the treatment allocation? (detection bias)
6. Was (were) the outcome measure(s) valid and reliable?
7. Was the care provider blinded to the study purpose?
8. Were drop-outs and loss to follow-up reported? If so was it less than 20% and balanced between groups? (attrition bias)
9. Was the intervention based on reasonable, physiological plausibility?
10. Was fidelity of intervention explicitly addressed in the study?

Nonequivalent pretest-posttest control group design OR Nonequivalent Posttest-only control group design

1. Is the study based on a representative sample of the population?
2. Were the eligibility criteria specified and logical in relation to the population and the intervention under study?
3. Were the groups similar at baseline? (selection/confounding bias)
4. Was attention bias addressed?
5. Were assessors blinded to the treatment allocation? (detection bias)
6. Was/were the care provider or subject blinded to the study purpose? (performance or attention bias)
7. Was (were) the outcome measure(s) valid and reliable?
8. Were drop-outs and loss to follow-up reported and balanced between groups? (attrition bias)
9. Was the intervention based on reasonable, physiological plausibility?
10. Was fidelity of intervention explicitly addressed in the study?

One-Group pretest-posttest design OR Time Series Design

1. Is the study based on a representative sample of the population?
2. Were the eligibility criteria specified and logical in relation to the population and the intervention under study?
3. Were assessors blinded? (detection bias)
4. Was/were the care provider or subject blinded to the study purpose? (performance or attention bias)
5. Was (were) the outcome measure(s) valid and reliable?
6. Were drop-outs and loss to follow-up reported, and explained? (attrition bias)
7. Was the intervention based on reasonable, physiological plausibility?
8. Was fidelity of intervention explicitly addressed in the study?

Single-case design

1. Did the type of design allow us to attribute change to the intervention (e.g., stable baseline, withdrawal/extinction phase, alternate treatment, follow-up)?
2. Were the subject eligibility criteria logical in relation to the population and the intervention under study?
3. Were the children's characteristics well described permitting determination who the results might apply too?
4. Was the intervention sufficiently described that it could be replicated?
5. Was fidelity of intervention addressed?
6. Was (were) the outcome measure(s) valid and reliable?
7. Was the assessor blinded to phases of the study (baseline vs. intervention)?
8. Was the intervention based on reasonable, physiological plausibility?

Cohort studies

1. Is there sufficient description of the groups and the distribution of prognostic factors?
2. Is the intervention/treatment reliably ascertained?
3. Were the groups comparable on all important confounding factors?
4. Was there adequate adjustment for the effects of these confounding variables?
5. Was a dose-response relationship between intervention and outcome demonstrated?
6. Was outcome assessment blind to intervention status?
7. Was (were) the outcome measure(s) valid and reliable?
8. Was follow-up long enough for the outcomes to occur?
9. Were drop-out rates and reasons for drop-out similar for each group?

Case-control studies

1. Is the case definition explicit?
2. Has the disease state of the cases been reliably assessed and validated?
3. Were the controls randomly selected from the source of population of the cases?
4. Are the cases and controls comparable with respect to potential confounding factors?
5. Does the study control adequately for confounding with design or statistics?
6. Were interventions and other exposures assessed in the same way for cases and controls?
7. Was the measurement of exposure or intervention kept blinded to the case or control group status?
8. Was (were) the outcome measure(s) valid and reliable?

9. Were the non-response rates and reasons for non-response the same in both groups?
10. Was an appropriate statistical analysis used (matched or unmatched)?

Quality Levels

High	A study that meets 70% or more of design-specific crtieria well.
Moderate	A study that meets at least 40% but less than 70% of design-specific criteria and has no known "fatal flaw."
Low	A study that meetes than 40% of design-specific criteria OR has at least one design-specific "fatal flaw". These studies' results should be interpreted with great caution as these studies are deemed to have limited ability to inform practice recommendations.

Levels of Evidence

Level I	Systematic reviews, meta-analyses, randomized controlled trials
Level II	Two groups, nonrandomized studies
Level III	One group, nonrandomized
Level IV	Descriptive studies that include analysis of outcomes (e.g., single subject design)
Level V	Case reports and expert opinion that include narrative literature reviews and consensus statements