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Schuell's Stimulation Approach Administered Intensively for an Individual with Chronic, Severe Non-Fluent Aphasia

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Schuell's Stimulation Approach Administered Intensively for an Individual with Chronic, Severe Non-Fluent Aphasia

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Table of Contents

Abstract

Background: Schuell's Stimulation Approach is frequently implemented within conventional speech language therapy (SLT) for aphasia. Recent research supports the use of intensive treatment, as well as the potential for continued gains in the chronic stage of aphasia. Given the limited evidence-based treatment options for individuals with chronic, severe non-fluent aphasia, investigation was warranted.

Aims: The current study used a single subject design with multiple probes across behaviors to investigate how an individual with chronic, severe non-fluent aphasia, who had ceased to make gains in conventional SLT, would respond to administration of Schuell's Stimulation Approach at the standard intensive dosage of 30 hours over 2 weeks, whether gains would be generalized to untrained stimuli, and whether gains would be maintained overall.

Methods & Procedures: A participant with chronic, severe non-fluent aphasia participated in daily therapy (3 hours/day for 10 days) targeting naming and auditory comprehension. Daily probes were administered for trained and untrained naming and auditory comprehension stimuli, as well as discourse. Standardized assessments, naming and auditory comprehension probes, and discourse measures were taken pre- and post- treatment and also 5 and 10-weeks after the completion of treatment.

Outcomes & Results: The participant showed clinically significant changes on standardized assessments, naming and auditory comprehension probes, with maintenance of gains in nearly all cases. Clinically significant changes were also found for untrained auditory comprehension stimuli indicating generalization.

Conclusions: Schuell's Stimulation Approach administered in an intensive dosage resulted in positive changes in aphasia severity for an individual with chronic, severe non-fluent aphasia who had ceased to make gains in conventional SLT. This study adds evidence for the role of increased intensity for participants who present similarly to realize additional receptive and expressive language improvements.

Note

This thesis reflects a working manuscript of a collaborative project conducted with Dr. Jennifer Mozeiko. Dr. Mozeiko and I have worked together with respect to conducting treatment, data collection and data analysis. This manuscript will be submitted for publication with shared authorship.

Introduction

Aphasia is defined as a general language deficit affecting all modalities of language including comprehension, speech, reading, and writing (Schuell, Jenkins & Jimenez-Pabon, 1964). Language recovery can continue after the period of spontaneous recovery at which time gains tend to plateaus (~ 1 year) (Cherney & Robey, 2001; Moss & Nicholas, 2006). According to Saur and Hartwigsen (2012), individuals show significant improvements of language abilities as well as increased activation patterns on fMRI measures within the first 4 months post onset, and during the following 4-12 months these changes become more gradual before a plateau is observed. Although the ceiling for recovery of impaired language function was previously defined to be between 6-12 months post stroke (Rosenbek, 1995), more recent research demonstrates that language recovery can continue even in the chronic stages of aphasia (Barthel, Meinzer, Djundia, & Rockstroh, 2008; Basso & Macis, 2011; Moss & Nicholas, 2006; Pulvermüller & Berthier, 2008, Purdy & Wallace, 2016). Additionally, a review by Moss and Nicholas (2006) concluded that individuals with chronic aphasia who have passed the period of spontaneous recovery have equal potential for improvement regardless of time post onset, as no significant correlations ($p > .05$) were found between time post onset and maximum possible change on verbal expression measures for participants with chronic aphasia.

Despite a rich body of aphasiology research available, there are limited treatments demonstrating positive effects for individuals with chronic, severe non-fluent aphasia. At one time it was believed that these individuals were not candidates for speech and language therapy at all (Sarno, 1970). Case studies demonstrating responsiveness to Melodic Intonation Therapy (Yamaguchi, 2012) and conversation-based therapy (Basso & Macis, 2011) however, provide evidence that gains remain possible. A case report by Yamaguchi (2012) investigated the use of

melodic intonation therapy in a participant with chronic, severe global aphasia and treatment yielded improvements for verbal expression of two social utterances ("hello" and "goodbye") and two body parts ("foot" and "ears"). In a study by Kurland, Pulvermüller, Silva, Burke & Andrianopoulos (2012), the use of constraint induced aphasia therapy (CIAT) yielded gains of at least 20% and large effect sizes (>10.1) on naming tasks for participants with chronic, moderate-to-severe aphasia with comorbid apraxia of speech. Like Melodic Intonation Therapy, CIAT is administered intensively; in this case with a dosage of treatment (3 hours per day for 10 days). The authors attributed the gains to the repetitive and intense nature of the treatment type that yielded increased cortical activation as measured by fMRI. In the study by Basso and Macis (2011), 23 participants with chronic aphasia of varying severities and types participated in an intensive conversation-based therapy and demonstrated significant gains ($p < .001$) on Token test scores, measures of oral and written naming, as well as sentence production. The authors additionally suggest that an intensive regimen may yield better outcomes for participants who do not realize gains on a less intensive dosage regimen, and found that aphasia severity was not a prognostic factor for continual gains in the chronic stage of aphasia. Despite the paucity of successful interventions documented for individuals with chronic, severe non-fluent aphasia, there is evidence that they do make gains and thus further investigation into effective treatments for these individuals is warranted.

A researcher by the name of Hildred Schuell had extensive clinical experience working with people with aphasia (PWA) and investigating the rehabilitation of linguistic deficits. Schuell believed that the auditory processes are the fundamental and core component to the complex system of language acquisition, processing, and control (Schuell, 1953; 1964). As such, the impaired access to the use of language across all modalities that is observed in PWA is

considered to be due to core auditory processing deficits. Schuell's Stimulation Approach is an approach to treatment where intensive stimulation is provided in order to train the auditory processor, thus facilitating gradual recovery of the impaired language systems (Coelho, Sinotte & Duffy, 2012; Duffy & Ulrich, 1976; Schuell, 1953b; Schuell, Jenkins, & Jiménez-Pabón, 1964). The underlying theory of this approach posits that language retrieval may be facilitated within a damaged language system through providing repetitive, intensive auditory stimulation that is designed to elicit a response from the individual with a focus on using individualized and personally relevant multimodal stimuli for the patient (Coelho et al., 2012). It is important to note that Schuell believed that the focus of aphasia treatment is not to teach the individual, but to assist in the successful access and retrieval of language. Schuell (1969) describes that language impairments occur due to performance factors as language is working with reduced efficiency, but is never truly lost. Schuell's Stimulation Approach, frequently implemented within traditional SLT for aphasia, is widely used due to its efficacy (Coelho et al., 2012; Darley, 1975; Davis, 1993; Marshall & Freed, 2006; Martins, Leal, Fonseca, Farrajota, Aguiar, Fonseca & Ferro, 2013; Prins, Schoonen & Vermuelen, 1989; Robey, 1998; Schewan, 1984).

Treatment intensity is a variable for aphasia therapy that has received considerable attention within the literature, with higher intensity treatment dosages tending to yield greater gains for PWA (Basso & Macis, 2011; Bhogal, Teasell, & Speechley, 2003; Brady, Godwin, Enderby & Campbell, 2016; Denes, Perrazolo, Piani, & Piccione, 1996; Hinckley & Carr, 2005; Mozeiko, Coelho, & Myers, 2016; Pulvermüller, Neininger, Elbert, Mohr, Rockstroh, Koebbel & Taub, 2001; Robey, 1998). In a literature review by Bhogal et al. (2003) investigating the intensity of therapy on aphasia recovery, studies that reported significant improvements were those where therapy was administered in an intensive dose over a short period of time (an

average of 8.8 hours per week for 11.2 weeks) as opposed to a less intensive dose (two 1 hour sessions per week for 22.9 weeks), with severe aphasics benefitting the most. According to a Cochrane review by Brady et al. (2016), participants who received a high intensity therapy regimen of 4-15 hours/week performed significantly better ($p=.02$) on aphasia severity measures and had better functional communication ($p=.003$) when compared to participants who received low intensity therapy of 1.5-5 hours/week.

The theory behind using high intensity of treatment allows for increased numbers of repetitions. This principle has been shown in motor rehabilitation literature to be necessary for neural reorganization and maintenance of gains following treatment (Kleim & Jones, 2008). Although this is a motor theory, the same high correlation between neuronal activations may also be similarly achieved with remediation of language impairments. As such, according to Pulvermüller and Berthier (2008), a massed practice principle applied to language rehabilitation suggests that intensive and repetitive treatment maximizes the amount and frequency of stimulation occurrence, thus translating to maximal response potential both at the neuronal and behavioral levels. This theory has parallels to associationist learning principle, or Hebbian learning (Hebb, 1949). According to Hebbian learning, repeated simultaneous activation of two systems of cells leads to new associations and changed connectivity patterns, where cells that fire together will wire together (Hebb, 1949; Varley, 2011). The Hebbian learning principle may have implications for adaptive plasticity following neural damage. An adult's brain has potential for neural plasticity following damage through synapse-based mechanisms where neurons are stimulated by sensory or motor input, and through compensatory rewiring and coincidental synaptic activation, the signals are redistributed around the damaged neural circuitry to the spared adjacent neural areas (Brown, Boyd, Delaney & Murphy, 2007; Murphy & Corbett,

2009). Pulvermüller and Berthier (2008) describe Hebbian learning principles in relation to effective aphasia therapy and suggest that in order to reactivate or rebuild the damaged language networks, therapy should be provided in massed practice and recognize the interconnectedness of sensory-perceptual and motor systems through providing well-structured input. They suggest that this will prime the neural processing networks for language expression. This principle applied to the Schuell's Stimulation Approach may have implications for adaptive plasticity, as the language system may be able to rebuild through repetitive multimodal stimulation capitalizing on processes of neural rewiring around the damaged neural area when well structured input is provided.

This study sought to utilize Schuell's Stimulation Approach of intensive stimulation of the auditory processor coupled with an intensive treatment dose of 30 hours over 2 weeks/10 days. Schuell's Stimulation Approach focuses on providing multimodal stimulation to rehabilitate an impaired language system through repetitive, intensive auditory stimulation to elicit a response from the PWA with a focus on using individualized and personally relevant stimuli to address the treatment goals of the individual. Aforementioned research tells us that individuals in the chronic stages of aphasia can still make gains and that the window for recovery does not close, rather recovery slows down. Additionally, prior research has shown that treatment administered intensively yields greater gains compared to treatment administered in a less intense dosage, even for persons with chronic aphasia. Mozeiko et al. (2016) suggest that the intensity of treatment might be core to influencing continued change for those with chronic aphasia. Although the participant in the current study with severe non-fluent chronic aphasia had ceased to make gains in conventional stimulation type SLT, it was hypothesized that he would make improvements in both expressive and receptive language when provided with an intensive

dose of Schuell's Stimulation Approach. This treatment approach capitalizes on neuroplastic mechanisms and neural rewiring through massed practice by intensively and repetitively stimulating the auditory processor, which is believed by Schuell to be core to language function and remediation.

This study investigated how a participant with very severe, chronic aphasia responded to Schuell's Stimulation Approach administered intensively. Assessments were collected during pre-treatment/baseline, during treatment, and at follow up to treatment. Daily probes were administered for both trained and untrained naming and auditory comprehension stimuli, with untrained stimuli being used to determine generalization. The participant's response to this treatment program was additionally assessed through comparison of pre-treatment and post-treatment standardized assessment battery scores measuring both language and cognition. This study included assessments of cognition as prior research has found that individuals with aphasia may additionally present with deficits in executive function (Chiou & Kennedy, 2009; Frankel, Penn & Ormond-Brown, 2007), as well as memory and attention (Murray, 1999, 2000). Cognitive impairments such as these are found to negatively influence functional communication given their role in the processing of linguistic input and in the overall success in communicative engagements (Fridriksson, Nettles, Davis, Morrow, & Montgomery, 2006; Nicholas, Sinnotte & Helm-Estabrooks, 2011; Murray, 2000; 2012; Purdy & Koch, 2006, Purdy & Wallace, 2015; Ramsberger, 2005). Given the severe nature of this individual's language impairment, it was important to also track any changes in cognition that would ultimately influence improved communication function. Finally, the current study investigated how the observed treatment effects would generalize to untrained stimuli as well as to verbal discourse.

The following questions were addressed in this study:

1. Will an intensive administration of Schuell's Stimulation Approach result in expressive and receptive language gains in an individual with chronic, severe non-fluent aphasia who had ceased to make gains with standard SLT?
2. Will treatment gains generalize to untrained stimuli and measures of verbal discourse?
3. Will treatment gains be maintained during follow up assessments?

Method

Participant

The participant (P) in the present study was a 60-year-old male, native English speaker who lived at home with a caregiver. P was premorbidly right handed, had completed 17 years of education, and was previously employed as a hotel manager. At the time of treatment initiation, he was 16 months post-onset of a large middle cerebral artery (MCA) cerebral vascular accident (CVA) that was confirmed by MRI imaging. P passed a pre-treatment hearing screening signifying adequate hearing for participation in this study. This participant presented with a dense right hemiparesis as well as severe non-fluent aphasia (Western Aphasia Battery Aphasia Quotient of 29.2) characterized by deficits in both expressive and receptive language but with relatively preserved repetition at the multiple word level. He demonstrated poor error awareness as well as difficulty following basic commands such as "point to the ceiling" despite maximum cueing and orientation to the task. His verbal expression was characterized by overlearned words and phrases as well as frequent verbal perseverations. According to his baseline AQ score on the WAB, he would be classified with isolated aphasia (See Table 1 for standardized assessment scores). He had been receiving SLT up until the beginning of treatment but according to his

speech and language pathologist (SLP) had ceased to make gains. The previous treating SLP described the treatment as a stimulation type therapy including tasks such as following single step commands and differentiating between 2-3 stimulus items. In addition, P attended a local aphasia group but throughout the duration of this study, he was receiving no form of individual or group language rehabilitation.

Experimental Design

This treatment study utilized a single subject design with multiple probes across behaviors (Thompson, 2006). This approach is the most commonly used (Coelho et al., 2012) and has been suggested to be the most suitable for aphasiology studies (Thompson, 2006), as we know that treatment improves language function (Holland, Fromm, DeRyuter & Stein, 1996), though research now aims to determine what particular disorders improve as a result of specific treatments (Thompson, 2006). Thompson (2006) describes how prior research in aphasiology with studies of between-group experiments that demonstrated overall improvements in language function did not distinguish among the severity and type of aphasia for the individuals in the studies. Therefore, the consumers of this research are unclear about what profile of aphasia benefitted the most (or least) from those defined treatments. According to Thompson (2006), due to the fact that individuals with aphasia are heterogenous, research that focuses on determining the effects of a specific treatment through averaging the results among multiple participants is contraindicated. Additionally, Thompson (2006) discusses how individuals with aphasia show intra-subject variability and a daily fluctuation is often observed in their individual performance. A benefit of a single subject experimental design allows for this fluctuation to be apparent as the

dependent variables of the study are repeatedly measured, whereas in a group study this daily fluctuation would not be captured.

Thompson (2006) describes well-controlled experimental research with single subjects through careful participant selection, thorough description of the treatment, defined outcome measures, and reliable data collection. Following these criteria, researchers able to determine interventions that are effective for participants that present similarly. Single subject experimental designs with multiple probes across behaviors are carefully planned and controlled, allowing for demonstration of internal validity as extraneous variables are controlled for, thus isolating the independent variable (i.e. treatment) to provide evidence for the effect of the treatment (i.e. changes on measured probes). Furthermore, generalization can be determined where changes are observed in behaviors that have not be targeted and trained (i.e. improved word retrieval for an untrained set of words). Generalization can also be determined when improvements are observed in untrained conditions (i.e. discourse or naturalistic communication settings). Thompson (2006) suggests that these changes should be systematically measured as well. Finally, external validity is addressed through direct and systematic replication of the treatment with additional participants that present similarly.

Schuell's Stimulation Approach to aphasia treatment was implemented according to the guidelines outlined by Coelho et al. (2012) following the aforementioned experimental design with an intense dosage of three hours per day for two weeks/10 days for 30 total hours.

Probing Schedule

Naming, auditory comprehension, and discourse probes were administered during pre-treatment/baseline and post-treatment assessments as well as during daily probing on treatment days. Stimuli were full-color photographs including 40 stimuli for trained nouns, 20 stimuli for

untrained nouns, 40 stimuli for trained auditory comprehension, and 20 stimuli for untrained auditory comprehension. Norman Rockwell images were used to probe discourse production. Stimuli were presented to the participant in a random order. No feedback or cueing was provided to the participant during probing.

Daily probes were administered prior to each treatment session in order to assess for changes in performance and to determine whether the participant was generalizing word retrieval and comprehension in both trained and untrained contexts. Daily probes were administered at the beginning of each session so as to avoid the influence of fatigue on performance (Murray, 1999).

Naming Probing:

The clinician provided the participant with a photograph from the set of naming stimuli. The participant was provided with the carrier phrase "This is a/an…" and the response was considered accurate if the participant provided a correct and intelligible verbal response to the stimuli.

Auditory Comprehension Probing

The clinician placed eight stimuli in front of the participant and elicited the participant's response by saying the name of the stimulus for which the participant then pointed to one of the eight choices. An accurate response was considered if the participant correctly identified the specified stimulus item from the set of eight stimuli on the first try. Additionally, one-step directions using trained stimuli cards were probed daily. Although not trained, non-verbal one-step directions (i.e. touch your shoulder) and verbal one-step directions (i.e. count to 10) were assessed during baseline and post-treatment sessions to determine additional generalization for auditory comprehension.

Discourse Probing

Discourse production was not treated but was probed as to assess for potential generalization from treatment to a natural form of language. The participant was provided with three Norman Rockwell images and the clinician elicited a response with the verbal prompt "Tell me what is happening in this picture". This was completed each day for three images that were provided randomly to the participant. In order to encourage the participant, the clinician provided the verbal prompt "Is there anything else?" or repeated the initial stimulus. There was no time limit on this task and the participant indicated completion with the image description. Responses were timed and then transcribed and analyzed for rate, word count (WC) and correct information units (CIUs) which refer to the number of non repeated words that are relevant to the targeted stimuli (Brookshire & Nicholas, 1994)

Experimental Stimuli

Full colored photographs of high frequency object nouns were used. Stimuli were chosen based on the theory of using words with a high frequency of occurrence as they are recognized more efficiently as compared to low frequency words (Gerratt & Jones, 1987; Hauk, & Pulvermüller, 2004). Using the MRC Psycholinguistic Database (Wilson, 1998), a word list was analyzed for both verbal and written frequency of occurrence and a subset of words from the list was generated. From this list, words were randomly distributed to be in the trained naming (40), untrained naming (20), trained auditory comprehension (40) and untrained auditory comprehension (20) (see Appendix A).

Treatment for Naming and Auditory Comprehension

The first session of treatment for the trained sets of stimuli began only after baseline performance remained stable over 3 consecutive days on all pre-treatment baseline probes. This was done in order to determine a consistent and accurate representation of the participant's performance prior to any treatment. The first half of the treatment session began with the 40 trained auditory comprehension stimuli. Examples of tasks included the clinician naming the targeted stimulus for which the participant then pointed to one of the provided choices beginning with sets of three and increasing only as he increased in performance. Additionally, the participant followed one-step directions (i.e. turn over the x) beginning with 1 card and increasing only as he increased in performance. During the second half of the treatment session, the clinician switched to the 40 trained naming stimuli where the participant produced the name of the target stimuli. A variety of cues and techniques were utilized throughout treatment to facilitate success on all tasks as described below.

Following guidelines by Schuell (1964), the stimuli was presented until a response was elicited, indicating then that the stimulus presented was adequate to activate the auditory processor. It should be noted that as many as 20 repetitions of a stimulus may be required before a response is elicited. This included repeating the stimuli with hierarchical cueing modifications as needed to ensure adequate stimulation. Hierarchical cueing was individually determined for the participant using the cueing program outlined by Linebaugh and Lehner (1977). According to Linebaugh and Lehner's cueing program, word retrieval is best facilitated by providing a minimal cue to elicit the target word, with gradually fading cues that serve to reinforce the underlying processes of word retrieval for increased efficiency. If the participant is unable to independently name the stimuli, Linebaugh and Lehner (1977) suggest the following hierarchy

as detailed by Coehlo et al. (2012) to elicit the appropriate response from the participant. 1.) Clinician states the object's function 2.) Clinician states and demonstrate the function 3.) Clinician provides sentence completion 4.) Clinician provides sentence completion plus a silent articulation of the first phoneme of the target word 5.) Clinician provides sentence completion plus the verbal production of the first phoneme 6.) Sentence completion plus the verbal production of the first sound 7.) Clinician provides sentence completion plus the verbal production of the first two phonemes 8.) Clinician produces the full word and the client repeats it. Following the accurate response by the participant, the order of the cues is reversed until the participant does not require the cue. It is important to note that cueing hierarchies must be individually determined for efficiency, as individual participants may benefit in variable ways to different cues.

The use of a variety of gestural, phonemic and semantic cues facilitated the participant in this study, and it has been shown that the use of phonological and semantic cues can be efficient in priming word retrieval (Nickels, 2002). For example, when the participant was unable to produce the name of the word independently, the clinician worked through the aforementioned hierarchy of cueing and it was found that the participant frequently only required the silent articulation of the first phoneme for accurate retrieval of the word. This example reflects the individualized nature of cueing that is described by Linebaugh and Lehner (1977). Additionally, modifications were made to ensure that the participant worked at a difficulty level at or below his maximum performance level (Marshall & Tompkins, 1982; McCall, Cox, Shelton & Weinrich, 1997). For example, during auditory comprehension treatment, the field of eight choices would first be reduced to two choices until the client was able to achieve 80% accuracy with the stimuli presented. From there, additional choices were added one by one (up to eight choices) while the

participant maintained at least 80% accuracy. This ensured success on the task and reduced the participant's frustration.

According to Coelho et al., (2012), some general principles for Schuell's Stimulation Approach are outlined as follows and were followed for this study:

Stimulation does not need to be limited to auditory stimulation if a more appropriate modality is warranted (i.e. a combined visual and auditory stimulation approach). If a response by the participant is inadequate, the clinician should not explain why, nor should they correct the individual's response. The primary purpose of the clinician is to provide appropriate stimulation in order to elicit maximum responses. The clinician must consider the impairments, severity, and prognosis of each individual and plan the treatment with these considerations in mind. Following the development of the treatment plan, the clinician should implement it with a focus on maximizing the number of responses elicited within the designated therapy time. Additionally, treatment materials and tasks should be of functional relevance to the participant, as doing so has been found to influence greater gains of restored skills in individuals with aphasia (Pulvermüller et al., 2001) which has been suggested to likely be due to the strong associational links in the brain for personally relevant stimuli (Coelho et al., 2012). Daily treatment should begin with stimulus items with which the PWA will have success. This initial success will facilitate their motivation for continuing with more challenging stimuli. According to Brookshire (1976), determining a starting point involves choosing tasks where the participant provides an immediate and correct response for 60-80% of stimuli. If the participant reaches 90% accuracy on the task, difficulty should be increased through variations in stimulus factors such as similarity, stress, and number of response choices. Additionally, stimulus tasks should challenge the individual to work at or just below their maximum performance level. If new treatment materials or tasks are

introduced, they should relate to the familiar materials so as to decrease the demands of learning and resource allocation, as the participant should focus on language processing.

Assessments

Baseline assessments were administered 3 weeks prior to treatment initiation. Follow up assessments were administered 1-week, 5-weeks, and 10-weeks post treatment (see Table 1). The assessments administered to the participant included the Western Aphasia Battery Revised-Aphasia Quotient (WAB R-AQ) (Kertesz, 2006), Boston Naming Test (BNT) (Kaplan et al., 2001), Raven's Coloured Progressive Matrices (RCPM) (Raven et al., 1986), and the Auditory Comprehension Test for Sentences (ACTS) (Shewan, 1979). The Test of Everyday Attention (TEA) (Ridgeway, Robertson, Ward, & Nimmo-Smith, 1994) as well as the Cognitive Linguistic Quick Test (CLQT) (Helm-Estabrooks, 2001) were both partially administered, but these tests were determined to be inappropriate for this participant and thus were not completed (See limitations).

Data Analysis:

Data was collected daily during probing of all stimuli sets (trained/untrained naming, trained/untrained auditory comprehension, and untrained discourse). It is expected that an individual with aphasia will experience performance variability day to day following a brain injury due to many factors including reduced efficiency and resource allocation as well as cognitive limitations and fatigue (Coelho et al., 2012; Lumsden, 1977, 1978; Murray, 1999, 2010; Thompson, 2006). As such, daily probes were recorded to document changes throughout the course of the study.

The effect sizes (ES) for auditory comprehension and naming probes were determined by subtracting the mean of the baseline probe scores from the mean of the two final probe scores and dividing this value by the standard deviation of the baseline probe scores. The benchmarks of ES significance are as follows: small: 4; moderate: 7; large: 10.1 (Beeson & Robey, 2006) Percent change was calculated for the non-verbal one-step directions, verbal one-step directions, and the trained one-step directions. Percent change was calculated by taking the difference of the final probe percentage and the baseline probe percentage and dividing that value by the baseline probe percentage, then multiplying by 100. A percent change greater than 20% (Ramsberger & Marie, 2007) was considered clinically significant.

Discourse probes were analyzed for rate, informativeness and efficiency. This was accomplished through transcribing each sample, completing a word count, timing each sample, and determining correct informational units following the protocol by Nicholas and Brookshire (1993). CIUs include words or intelligible paraphasias that are relevant to the description being provided. Three probes were administered on each day, and the analyses for these probes were averaged.

Percent change was calculated for the standardized assessments and a change greater than 20% (Ramsberger & Marie, 2007) or an effect size (ES) greater than 4 (Beeson & Robey, 2006) was considered clinically significant for all assessments aside from the WAB R-AQ. Historically, a 5 point change on the score for the WAB AQ has been classified as clinically significant (Shewan & Kertesz, 1980) but Rasch analysis suggests that there is a variable standard error of measurement (SEM) for the WAB AQ, dependent on the severity of aphasia. For an AQ between 30-70, the SEM is <2 points, whereas for an AQ less than 20 or greater than 90, the SEM is >6 (Hula, Donovan, Kendall, & Gonzales-Rothi, 2010). For this individual whose

pre-treatment AQ was 29.2, the SEM is <2 points, therefore a WAB R- AQ change of 3 or higher would indicate an effect of treatment.

Results:

Pre-Post Treatment Assessments:

Clinically significant gains were observed at 1-week post treatment assessment. The participant improved by 19 points on the WAB R-AQ; a 75% improvement on the BNT; and a 60% increase on the ACTS. These gains were maintained at the 5-week follow up, and continued to increase for the BNT (199% increase). During the 10-week follow up, clinically significant gains were maintained for the WAB R-AQ, and the BNT continued to increase (249% increase). Gains were not maintained for the ACTS at 10-weeks post treatment. On the RCPM, clinically significant gains (27% increase) were observed at 10-weeks post treatment (See Table 1).

Naming Probes:

A large effect size of 23.09 was observed for trained naming probes and a small effect size of 2.89 was observed for untrained naming probes (See Figure 1).

Auditory Comprehension Probes:

A moderate effect size of 8.95 was observed on trained auditory comprehension probes and a small effect size of 2.35 was observed for untrained auditory comprehension probes (See Figure 2). Additionally, one-step directions (i.e. turn over the X) that were trained throughout auditory comprehension therapy demonstrated a 50% improvement, and untrained one-step directions demonstrated a 100% improvement when comparing baseline to 10-weeks post treatment (See Figure 3).

Percent change was calculated for untrained verbal one-step directions (i.e. count to 10) and untrained nonverbal one-step directions (i.e. touch your nose). A 40% improvement was observed for verbal one-step directions, and a 350% improvement was observed for nonverbal one-step directions (See Figure 4).

Discourse probes:

Due to the nature and severity of this participant's language impairments, significant gains on discourse probe measures were not expected and increases in productivity (CIUs/WC) were not observed for this participant.

Qualitative Results:

Anecdotal evidence was gathered throughout this treatment study. During the initial sessions with this participant, subjective observations were documented on pertaining to the participant's frequent impulsive responses, verbal perseverations, and waning attention. As the participant's attention waned, it was observed that performance decreased and subsequently agitation increased. Thus, short breaks were observed to be beneficial to performance. Improvements were observed for attention as well as reduced frequency of impulsive responses and verbal perseverations over the course of the study. To illustrate the observed decrease in perseverations, randomly selected 5-minute samples of speech were collected and analyzed during pretreatment, during treatment, as well as post-treatment. During pre-treatment, the participant was observed to produce 15 verbal perseverations. For example, he would frequently perseverate on the phrase "snow white and the seven dwarves". During treatment (day 5), the participant produced 8 perseverations and at 1-week post treatment, the participant produced 6 perseverations.

It should also be noted that unsolicited comments were provided to the author of this study from the participant's caregiver regarding observations of the participant's improved focus during communication as well as more relevant responses. The participant had ceased participation in a local aphasia group (as well as any additional SLT) during the time of this study. Following his return to the group, student clinicians provided unsolicited comments to the author of this paper regarding their observations that the participant was less impulsive when responding to questions, maintained greater focus when following conversations, and made more relevant and related contributions within this group therapy setting.

Discussion

This study was a preliminary investigation into how an individual with chronic, severe non-fluent aphasia would respond to Schuell's Stimulation Approach delivered at an intensive dosage. This individual had ceased to make gains in conventional stimulation type SLT at a dosage of 2 hours of therapy per week. Aspects of Schuell's Stimulation Approach are widely utilized in clinical practice for individuals with aphasia due to it's efficacy and is considered a conventional and traditional approach to SLT for individuals with aphasia (Coelho et al., 2012, Darley, 1975; Davis, 1993; Marshall & Freed, 2006; Martins et al., 2013; Prins et al., 1989; Robey, 1998; Schewan, 1984). In studies of individuals with chronic aphasia, language recovery can continue (Barthel et al., 2008; Basso & Macis, 2011; Moss & Nicholas, 2006; Pulvermüller & Berthier, 2008, Purdy & Wallace, 2016) and is not dependent on the time post onset of neurological damage as there is equal potential for response to treatment for individuals in the chronic stages of aphasia (Basso & Macis, 2011). In studies that have utilized intensive dosages, greater linguistic gains have been appreciated as compared to non-intensive dosages of treatment

(Bhogal et al., 2003; Brady et al., 2016; Denes et al., 1996; Hinckley & Carr, 2005; Mozeiko et al., 2016; Pulvermüller et al., 2001; Robey, 1998). Therefore, it was predicted that increasing the intensity of this traditional stimulation type SLT approach would be a main factor for gains following this treatment study with a participant with chronic, severe non-fluent aphasia who had ceased to make gains at a more standard treatment dosage of 2-3 hours per week.

Efficacy

Data from this study support the contribution of intensity to a treatment type that is frequently used in clinical practice. The study sought to investigate the following questions: 1) Will an intensive administration of Schuell's Stimulation Approach result in expressive and receptive language gains in an individual with chronic, severe non-fluent aphasia who had ceased to make gains with standard SLT? 2) Will treatment gains generalize to untrained stimuli and measures of verbal discourse? 3) Will treatment gains be maintained during follow up assessments?

Schuell's Stimulation Approach utilizing an intense treatment schedule of 30 hours over two weeks induced clinically significant gains on standardized assessments as well as trained naming and auditory comprehension probes and untrained auditory comprehension probes. Gains were maintained upon 5 and 10-week follow up assessments reflecting generalization to untrained stimuli. Given the nature and severity of this individual's aphasia, it was not expected that generalization to measures of discourse would occur, and as predicted, gains on discourse measures were not observed. Continued gains were observed on the BNT, reflecting a treatment effect that extended beyond the treatment itself as none of the words presented in the BNT were included in the trained items. Clinically significant gains on standardized assessments were made and maintained on all but one measure (ACTS) which may have reflected the individual's

increased fatigue as this measure was assessed last on the final assessment day. The gains made and maintained on both standardized assessments and expressive and receptive language probes reflect increased linguistic function following an intensive dosage of treatment, as increased intensity was necessary for this participant to realize gains at this point in his recovery. Furthermore, it should be noted that improvements within functional everyday communication is a component of optimizing treatment in individuals with aphasia, so capturing these qualitative changes reflects a person-centered and multi-faceted intervention (Galletta & Barrett, 2014). Therefore, it was relevant to include anecdotal evidence of improvement reported from individuals who were involved with this participant as this provided information regarding the participant's improved communication in everyday, naturalistic settings.

Limitations

This participant's performance and participation was limited by his daily performance variability as well as fatigue. An intensive treatment program can be exhausting for a participant, and it was observed that this participant demonstrated waning attention and subsequent decreases in performance as he became fatigued throughout the sessions. The clinician observed these moments and provided short breaks (1-2 minutes to rest or converse) occasionally as needed throughout the session. The participant also had a 10-minute break at about halfway through each session to walk around the clinic and use the restroom as needed. Furthermore, It was difficult to parse cognition and language function due to the severity of impairments. Consequently, assessments of cognition were limited to portions that the participant could complete, as not all portions were appropriate given the individual's severity of deficits.

Conclusions

An intensive treatment administration (30 hours/2 weeks) of Schuell's Stimulation resulted in clinically significant effects for one individual with chronic, severe non-fluent aphasia as evidenced by large gains that were maintained during follow up assessments on standardized assessments and trained naming and auditory comprehension probes. Clinically significant effects were observed for some measures of untrained auditory comprehension reflective of treatment generalization. While clinically significant gains were observed on the WAB-R AQ on all follow up assessments, a small decline was observed at week 10 compared to immediately post treatment. This may reflect that if the PWA is not in an environment utilizing what has been learned, gains may not be maintained. According to Kurland et al. (2012), often individuals with chronic aphasia develop a learned non-use of language due to the difficulty communicating that they experience. Research by Kurland et al. (2012) concluded that 2 weeks of treatment provides a "kick-start" to overcoming a learned non-use of language for individuals with chronic aphasia, but maintenance and generalization to more functional communication engagements continues to pose a challenge. Given this, further investigations are warranted into how interventions can elicit changes that are both maintained and generalized to functional communication. Furthermore, it is logistically difficult to find a group of individuals presenting with similar deficits, but due to the limited research available for individuals with chronic, severe non-fluent aphasia, investigation into effective treatment for this population was warranted for this study, and future research should continue to investigate these questions. An alternative treatment also utilizing intensity such as CIAT may actually be inappropriate for individuals of this severity, given factors such as paucity of verbal speech, the frequency of verbal perseverations, increased agitation, and difficulties maintaining attention, as CIAT restricts all responses to the verbal

modality. Schuell's Stimulation Approach administered intensively may be a viable alternative for these participants, as increased intensity is necessary for participants who present similarly to realize gains during the chronic stages of aphasia.

Appendix

Table 1

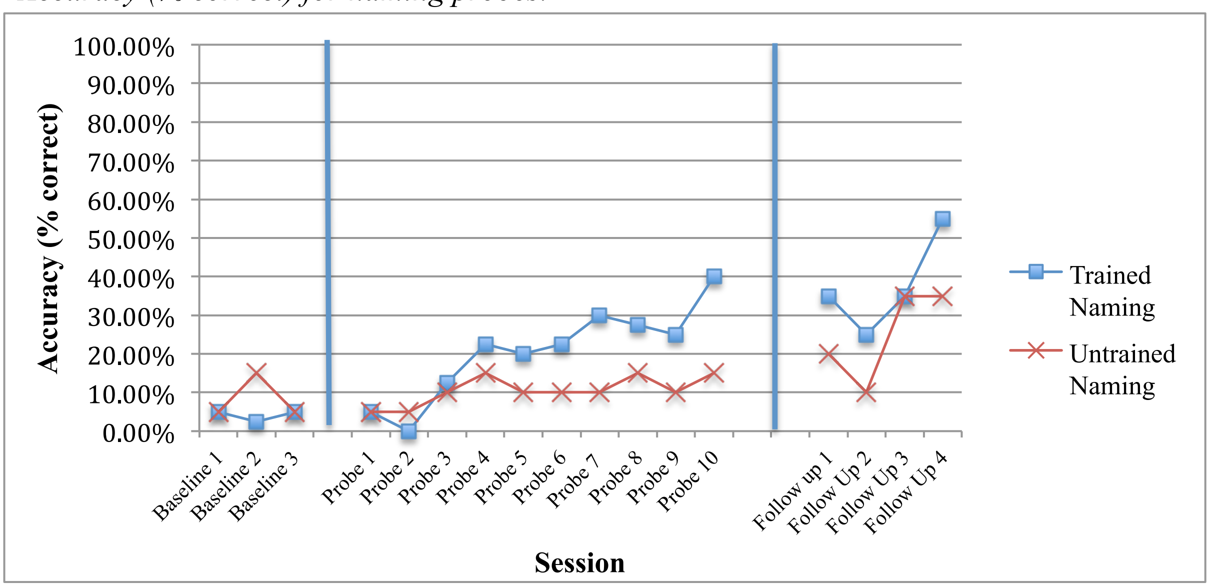
Standardized assessment scores.

Assessment	Pre-tx	Post-tx	Follow up-1	Follow up-2
WAB R-AQ	29.2	48.2 **	46.7 **	44.7 **
RCPM	47.2%	52.8%	55.6%	58.3% **
BNT	6.7%	11.7% **	20% **	23.3% **
ACTS	23.8%	38.1% **	38.1% **	9.5%

Note: RCPM, BNT, and ACTS scores are recorded as a percentage of maximum possible score. (**) Indicates clinically significant change based on post-tx scores compared to pre-tx score. Significance is determined by 3+ points on the WAB R-AQ (Hula et al., 2010), a 20% or greater change when unspecified on other standardized tests (Ramsberger & Marie, 2007), or an effect size (ES) greater than 4 (Beeson & Robey, 2006). Pre-tx: 3 weeks prior to tx, post-tx: 1-week post- tx, follow up-1: 5 weeks post-tx, follow up 2: 10 weeks post-tx.

Figure 1

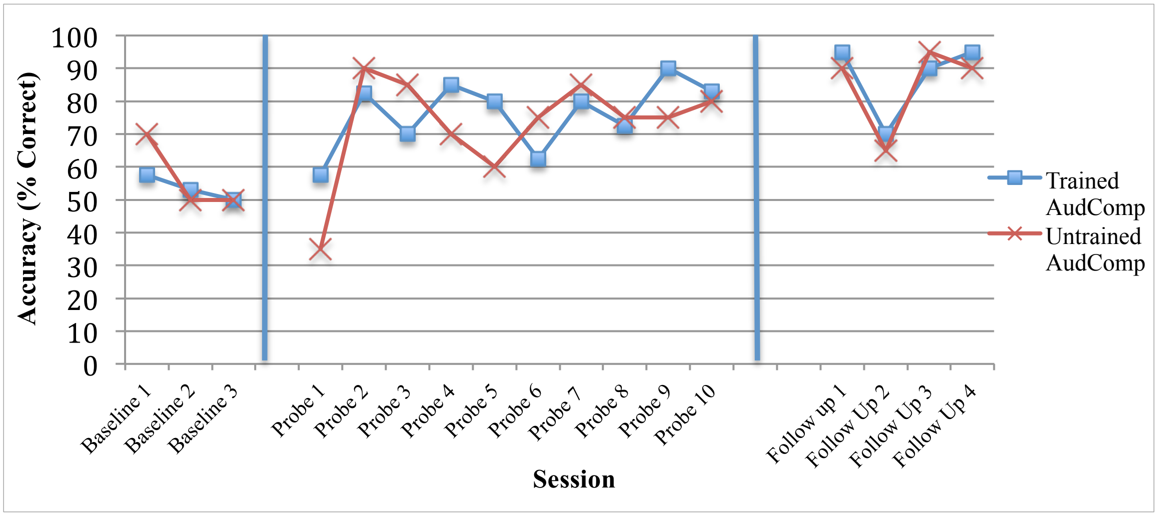
Accuracy (% correct) for naming probes.



Note: Follow up 1 and 2 were at 1-week post-tx, Follow up 3: 5 weeks post-tx, Follow up 4: 10 weeks post-tx.

Figure 2

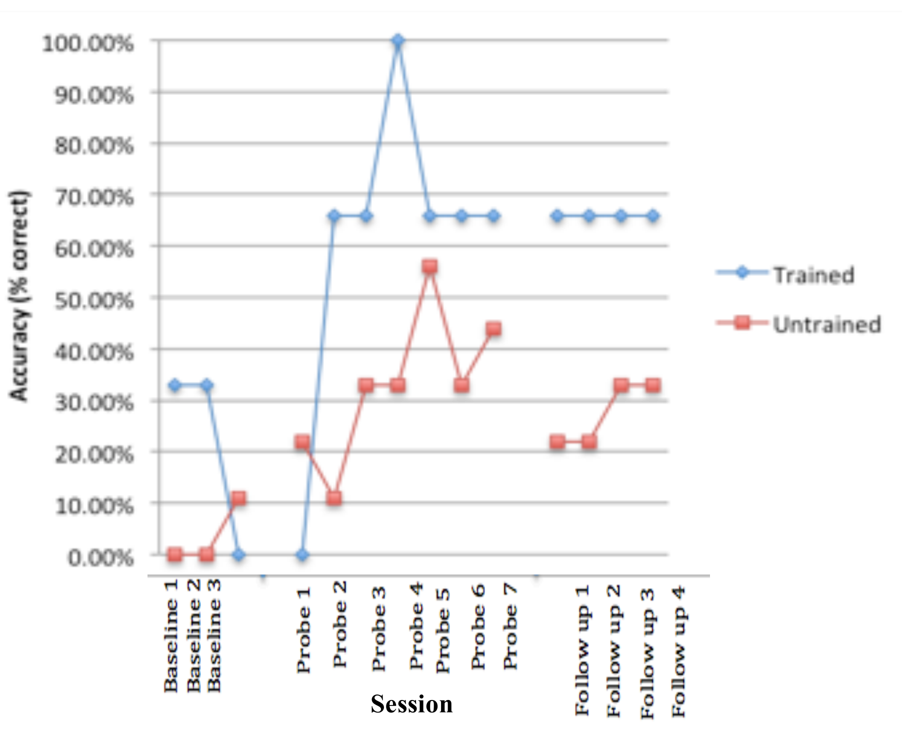
Accuracy (% correct) for auditory comprehension probes.



Note: Follow up 1 and 2: 1 week post-tx Follow up 3: 5 weeks post-tx, Follow up 4: 10 weeks post-tx.

Figure 3

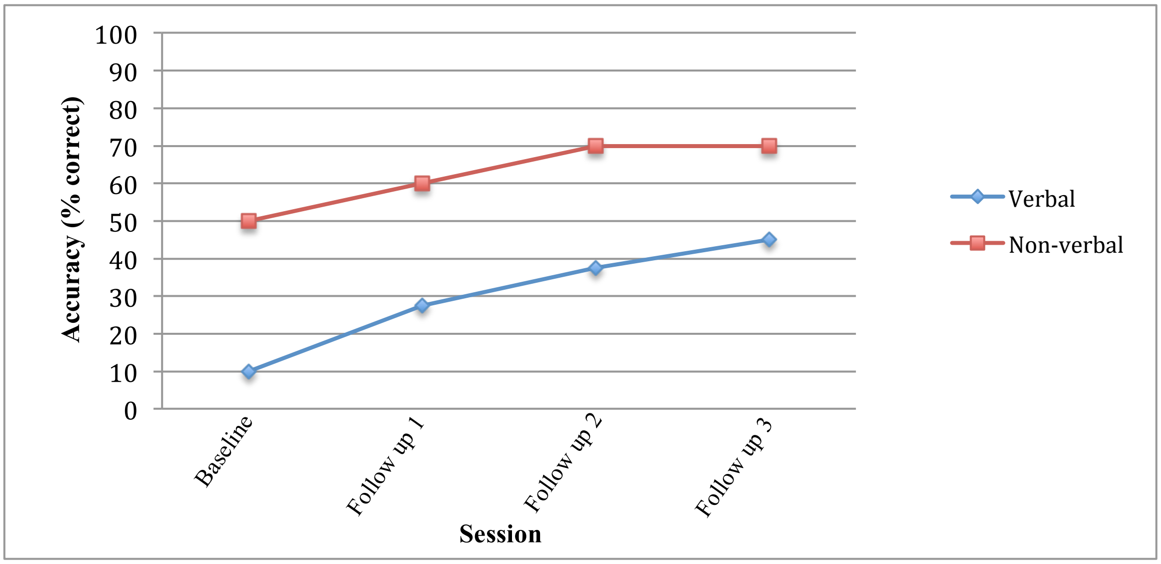
Accuracy (% correct) for one-step directions.



Note: Follow up 1 and 2: 1 week post-tx Follow up 3: 5 weeks post-tx, Follow up 4: 10 weeks post-tx.

Figure 4

Accuracy (% correct) for non-verbal one step directions and verbal one step directions.



Note: Baseline was at 3-weeks pre-tx, follow up 1 was 1-week post-tx, follow up 2 was 5 weeks post-tx, and follow up 3 was 10 weeks post-tx.

Appendix A

Word lists.

Trained Auditory Comprehension		Untrained Auditory Comprehension	Trained Naming		Untrained Naming
referee	pot	cabbage	frog	mirror	zipper
scarf	blanket	jam	broom	ear	owl
bucket	jacket	umbrella	clown	fly	worm
garbage	beer	cheese	vase	corn	stool
flashlight	chicken	sandwich	hook	snake	turtle
glove	smoke	airplane	pear	ring	turkey
salad	meat	priest	comb	cross	balloon
hose	salt	fountain	trumpet	truck	rabbit
chocolate	dollar	screw	pig	box	tub
thumb	phone	bowl	pants	watch	razor
leaf	hat	tea	button	ship	fan
rug	newspaper	bird	drum	bridge	cow
stove	coffee	drill	egg	heart	belt
bell	mouth	bread	toilet	shark	bus
amp	sun	dirt	rope	sock	fish
toast	fire	suit	basket	tree	brush
clock	feet	wood	pen	tooth	knife
plate	hand	glass	ladder	shoe	train
beard	house	table	tire	ant	key
butter	wine	door	sink	horse	window

References

Basso, A. (2005). How intensive/prolonged should an intensive/prolonged treatment be?. *Aphasiology*, *19*(10-11), 975-984.

Basso, Anna. “Natural” conversation: A treatment for severe aphasia. *Aphasiology* 24.4 (2010): 466-479.

Basso, A., & Macis, M. (2011). Therapy efficacy in chronic aphasia. *Behavioural Neurology*, *24*(4), 317-325.

Barthel, G., Meinzer, M., Djundja, D., & Rockstroh, B. (2008). Intensive language therapy in chronic aphasia: Which aspects contribute most?. *Aphasiology*, *22*(4), 408-421.

Beeson, P. M., & Robey, R. R. (2006). Evaluating single‐subject treatment research: Lessons learned from the aphasia literature. *Neuropsychology review*, 16(4), 161‐ 169.

Bhogal, S. K., Teasell, R., & Speechley, M. (2003). Intensity of aphasia therapy, impact on recovery. *Stroke*, 34(4), 987‐993.

Brady, M. C., Kelly, H., Godwin, J., & Enderby, P. (2012). Speech and language therapy for aphasia following stroke. *The Cochrane Library*.

Brindley P, Copeland M, Demain C, Martyn P. A comparison of the speech of ten chronic Broca’s aphasics following intensive and non-intensive periods of therapy. *Aphasiology*. 1989;3:695–707.

Brookshire, R.H. (1977). A system for coding and recording events in patient-clinician interactions during aphasia treatment sessions. In M. Sullivan and M.S. Kommers (Eds.), Rationale for adult aphasia therapy. Omaha, University of Nebraska Medical Center.

Brookshire, R. H. (1976). A System for Coding and Recording Events in Patient-Clinitian Intersections during Aphasia Treatment Sessions. In *Clinical Aphasiology: Proceedings of the Conference 1976* (pp. 224-236). BRK Publishers.

Cherney L, Robey R. Aphasia treatment: recovery, prognosis, and clinical effectiveness. In: Chapey R, ed. Language Intervention Strategies in Aphasia and Related Neurogenic Communication Disorders. Philadelphia, Pa: Lippincott Williams & Wilkins; 2001.

Chiou, H., & Kennedy, M. (2009). Switching in adults with aphasia. *Aphasiology*, 23, 1065–1075.

Coelho, C. A., Sinotte, M. P., & Duffy, J. R. (2012). Schuell’s stimulation approach to rehabilitation. Language intervention strategies in aphasia and related neurogenic communication disorders, 5, 403‐449.

Darley, F.L. (1975). Treatment of acquired aphasia. In W.J. Friedlander (ed.), Advances in neurology, Vol. 7, New York: Raven Press.

Davis, G.A. (1993). A survey of adult aphasia and related language disorders 2 ed.. Englewood Cliffs, NJ: Prentice-Hall.

Denes, G., Perazzolo, C., Piani, A., & Piccione, F. (1996). Intensive versus regular speech therapy in global aphasia: A controlled study. Aphasiology, 10, 385–394.

Duffy, R. J., & Ulrich, S. R. (1976). A comparison of impairments in verbal comprehension, speech, reading, and writing in adult aphasics. Journal of Speech and Hearing Disorders, 41(1), 110‐119.

Frankel, T., Penn, C., & Ormond-Brown, D. (2007). Executive dysfunction as an explanatory basis for conversation symptoms of aphasia: A pilot study. *Aphasiology*, 21, 814–828.

Fridriksson, J., Nettles, C., Davis, M., Morrow, L., & Montgomery, A. (2006). Functional communication and executive function in aphasia. *Clinical linguistics & phonetics*, *20*(6), 401-410.

Galletta, E. E., & Barrett, A. M. (2014). Impairment and functional interventions for Aphasia: Having it all. *Current physical medicine and rehabilitation reports*, *2*(2), 114-120.

Hauk, O., & Pulvermüller, F. (2004). Effects of word length and frequency on the human event‐ related potential. Clinical Neurophysiology, 115(5), 1090‐1103.

Hebb, D. (1949). The organization of behavior. New York: Wiley

Helm‐Estabrooks, N. (2001). Cognitive Linguistic Quick Test: Examiner's Manual. Psychological Corporation.

Hinckley, J. J., & Carr, T. (2005). Comparing the outcomes of intensive and non‐ intensive context‐ based aphasia treatment. Aphasiology, 19, 965–974.

Holland, A. L., Fromm, D. S., DeRuyter, F., & Stein, M. (1996). Treatment Efficacy Aphasia. *Journal of Speech, Language, and Hearing Research*, *39*(5), S27-S36.

Hula, W., Donovan, N. J., Kendall, D. L., & Gonzalez-Rothi, L. J. (2010). Item response theory analysis of the Western Aphasia Battery. *Aphasiology*, *24*(11), 1326-1341.

Kaplan, E., Goodglass, H., & Weintraub, S. (2001). Boston naming test. Pro‐ed.

Kertesz, A. (2006). Western aphasia battery‐revised (WAB‐R). Austin, TX: Pro‐Ed.

Kleim, J. A., & Jones, T. A. (2008). Principles of experience-dependent neural plasticity: implications for rehabilitation after brain damage. *Journal of speech, language, and hearing research*, *51*(1), S225-S239.

Kurland, J., Pulvermüller, F., Silva, N., Burke, K., & Andrianopoulos, M. (2012). Constrained versus unconstrained intensive language therapy in two individuals with chronic, moderate-to-severe aphasia and apraxia of speech: behavioral and fMRI outcomes. *American journal of speech-language pathology*, *21*(2), S65-S87.

Linebaugh, C., & Lehner, L. (1977). Cueing hierarchies and word retrieval: a therapy program. In R.H. Brookshire (Ed.), Clinical Aphasiology Conference Proceedings, Minneapolis, MN: BRK.

Marshall, R. C., & Freed, D. B. (2006). The personalized cueing method: From the laboratory to the clinic. *American Journal of Speech-Language Pathology*, *15*(2), 103-111.

Martins, I. P., Leal, G., Fonseca, I., Farrajota, L., Aguiar, M., Fonseca, J., & Ferro, J. M. (2013). A randomized, rater-blinded, parallel trial of intensive speech therapy in sub-acute post-stroke aphasia: the SP-I-R-IT study. *International Journal of Language & Communication Disorders*, *48*(4), 421-431.

McCall, D., Cox, D. M., Shelton, J. R., & Weinrich, M. (1997). The influence of syntactic and semantic information on picture-naming performance in aphasic patients. *Aphasiology*, 11(6), 581-600.

Moss, A., & Nicholas, M. (2006). Language rehabilitation in chronic aphasia and time postonset. *Stroke*, *37*(12), 3043-3051.

Mozeiko, J., Coelho, C. A., & Myers, E. B. (2016). The role of intensity in constraint-induced language therapy for people with chronic aphasia. *Aphasiology,* 339-363.

Murray, L. L. (1999). Review attention and aphasia: Theory, research and clinical implications. *Aphasiology*, *13*(2), 91-111.

Murray, L. L. (2000). The effects of varying attentional demands on the word retrieval skills of adults with aphasia, right hemisphere brain damage, or no brain damage. *Brain and language*, *72*(1), 40-72.

Murray, L. L. (2012). Attention and other cognitive deficits in aphasia: Presence and relation to language and communication measures. *American Journal of Speech-Language Pathology*, *21*(2), S51-S64.

Murphy, T. H., & Corbett, D. (2009). Plasticity during stroke recovery: from synapse to behaviour. *Nature Reviews Neuroscience*, *10*(12), 861-872.

Nicholas, L. E., & Brookshire, R. H. (1993). A system for scoring main concepts in the discourse of non-brain-damaged and aphasic speakers. *Clinical Aphasiology,* 21, 87-99.

Nicholas, L. E., & Brookshire, R. H. (1993). A system for quantifying the informativeness and efficiency of the connected speech of adults with aphasia. *Journal of Speech, Language, and Hearing Research*, *36*(2), 338-350.

Nicholas, M., Sinotte, M. P., & Helm-Estabrooks, N. (2011). C-Speak Aphasia alternative communication program for people with severe aphasia: Importance of executive functioning and semantic knowledge. *Neuropsychological rehabilitation*, *21*(3), 322-366.

Prins RS, Schoonen R, Vermuelen J. (1989) Efficacy of two different types of speech therapy for aphasic patients. *Applied Psycholinguistics*; 10(1):85–123.

Pulvermüller, F., & Berthier, M. L. (2008). Aphasia therapy on a neuroscience basis. *Aphasiology*, *22*(6), 563-599.

Purdy, M., & Koch, A. (2006). Prediction of strategy usage by adults with aphasia. *Aphasiology*, 20, 337–348.

Purdy, M., & Wallace, S. E. (2016). Intensive multimodal communication treatment for people with chronic aphasia. *Aphasiology*, *30*(10), 1071-1093.

Ramsberger, G. (2005). Achieving conversational success in aphasia by focusing on non-linguistic cognitive skills: A potentially promising new approach. *Aphasiology*, *19*(10-11), 1066-1073.

Ramsberger, G., & Marie, B. (2007). Self-administered cued naming therapy: A single-participant investigation of a com- puter-based therapy program replicated in four cases. *American Journal of Speech-Language Pathology,* 16, 343–358.

Raven, J. C., Court, J. H., & Raven, J. (1986). Raven's Coloured Progressive Matrices. London: H. K. Lewis & Co.

Ridgeway, V., Robertson, I. H., Ward, T., & Nimmo-Smith, I. (1994). Test of everyday attention. Bury St. Edmunds, England: Thames Valley Test Company.

Robey, R. R. (1998). A meta-analysis of clinical outcomes in the treatment of aphasia. *Journal of Speech, Language, and Hearing Research*, *41*(1), 172-187.

Rosenbek, J. C., LaPointe, L. L., & Wertz, R. (1995). Aphasia: A clinical approach. Boston: College-Hill Press.

Sarasso, S., Santhanam, P., Määtta, S., Poryiazova, R., Ferrarelli, F., Tononi, G., & Small, S. L. (2010). Non-fluent aphasia and neural reorganization after speech therapy: insights from human sleep electrophysiology and functional magnetic resonance imaging. *Archives italiennes de biologie*, *148*(3), 271.

Sarno, M. T., Silverman, M., & Sands, E. (1970). Speech therapy and language recovery in severe aphasia. *Journal of Speech, Language, and Hearing Research*, *13*(3), 607-623.

Saur, D., & Hartwigsen, G. (2012). Neurobiology of language recovery after stroke: lessons from neuroimaging studies. *Archives of physical medicine and rehabilitation*, *93*(1), S15-S25.

Schuell, H. (1953). Auditory impairment in aphasia: Significance and retraining techniques. *Journal of Speech and Hearing Disorders,* 18(1), 14–21.

Schuell, H. (1953b). Aphasic difficulties understanding spoken language. *Neurology,* 3(3), 176–176.

Schuell, H., Jenkins, J. J., & Jimenez–Pabon, E. (1964). Aphasia in adults. Harper & Row.

Schuell, H. (1974). Aphasia Theory and Therapy: Selected Lectures and Papers of Hildred Schuell. Ed. with an Introductory Chapter by LF Sies. L. F. Sies (Ed.). University Park Press.

Schuell, H. (1969). Aphasia in adults. (NINDS, Monograph No. 10). Human communication and its disorders. Washington, D.C.: Department of Health, Education and Welfare, National Institutes of Health.

Shewan, C. M. (1979). Auditory comprehension test for sentences. Chicago, IL: Biolinguistics Clinical Institutes.

Shewan, C. M., & Donner, A. P. (1988). A comparison of three methods to evaluate change in the spontaneous language of aphasic individuals. *Journal of communication disorders*, *21*(2), 171-176.

Shewan, C. M., & Kertesz, A. (1980). Reliability and validity characteristics of the Western Aphasia Battery (WAB). *Journal of Speech and Hearing Disorders*, *45*(3), 308-324.

Springer, L., Willmes, K., & Haag, E. (1993). Training in the use of wh-questions and prepositions in dialogues: A comparison of two different approaches in aphasia therapy. *Aphasiology*, *7*(3), 251-270.

Teasell, R. W., Foley, N. C., Bhogal, S. K., & Speechley, M. R. (2003). An evidence-based review of stroke rehabilitation. *Topics in Stroke Rehabilitation*, *10*(1), 29-58.

Thompson, C. K. (2006). Single subject controlled experiments in aphasia: The science and the state of the science. *Journal of Communication Disorders*, *39*(4), 266-291.

Varley, R. (2011). Rethinking aphasia therapy: A neuroscience perspective. *International Journal of Speech-Language Pathology*, *13*(1), 11-20.

Wilson, M.D. (1988) The MRC Psycholinguistic Database: Machine Readable Dictionary, Version 2. Behavioural Research Methods, Instruments and Computers, 20(1), 6–11.

Yamaguchi, S., Akanuma, K., Hatayama, Y., Otera, M., & Meguro, K. (2012). Singing therapy can be effective for a patient with severe nonfluent aphasia. *International Journal of Rehabilitation Research*, *35*(1), 78-81.