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Treatment of Underlying Forms and Constraint Induced Auditory Training in Aphasia: A Single Case Study

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Treatment of Underlying Forms and Constraint Induced Auditory Training in Aphasia: A Single Case Study

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Abstract

PROBLEM:

High prevalence and pervasiveness of cognitive deficits post-stroke have been identified in recent research (Mellon et al., 2015; Jokinen et al., 2015). These deficits impact not only independence in daily living, but also impact therapeutic outcomes. Traditional cognitive-linguistic therapy approaches explicitly address restoration of linguistic components but do not explicitly address cognitive deficits, such as auditory attention, that are frequently observed post-stroke. With rates up to 46-92%, attention has been identified as the most prominent stroke-related cognitive/neuropsychological change reported in acute stroke survivors (Barker-Collo et al., 2009). Limited evidence of the effect of auditory processing training on cognitive linguistic skills exists. Constraint Induced Auditory Training (CIAT) is a dichotic listening auditory training program that has garnered attention for use with PWAs in recent years (Hurley & Davis, 2011). Preliminary studies of PWAs have shown positive outcomes after CIAT, including auditory processing abilities, increased neural activity in auditory processing pathways, perceptual improvements, and increased participation in activities of daily living (Hurley & Davis, 2011). Currently, there are very few studies that investigate the combined effects of a cognitive-linguistic therapy (such as Treatment of Underlying Forms [TUF]) and auditory processing training (such as CIAT) on overall language abilities. This study was conducted to examine treatment and overall language outcomes of TUF used in combination with CIAT in a PWA with moderate aphasia.

PROCEDURE:

Effects of explicit auditory training on overall language abilities using CIAT and cognitive-linguistic therapy (TUF) were examined using a single-subject research design (A1BA2CA3). The subject was a 74-year-old female stroke survivor with moderate aphasia, 3.5 years post-onset. Treatment outcomes were measured prior to and following two different blocks of treatment (Block 1-TUF in isolation; Block 2-TUF in combination with CIAT). Treatment outcomes were analyzed using non-parametric statistics and subjective methods. Analyses used included test of proportions, effect size, visual inspection using a two-standard deviation method, and Nicholas and Brookshire’s (1993) discourse analyses measures.

FINDINGS:

TUF, used in isolation, resulted in increased comprehension of active, canonical sentences, verb naming and comprehension, and argument structure production. TUF used in combination with CIAT resulted in increases in auditory comprehension, aphasia quotient, as well as increase in verb naming. Repetition abilities also greatly improved, though not statistically significant. CIAT used in combination with TUF was more effective in improving language functions as compared to TUF alone. More research is warranted in order to understand effects of auditory training on cognitive-linguistic therapies.

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Chapter I: Introduction

Two regions of the brain are critical for processing of language used in everyday communication. Broca's area, located in the frontal lobe of the brain, is responsible for planning and programming the motoric production of language; Wernicke's area, located in the temporal lobe, contributes to comprehension functions of language. Damage to these areas of the brain may result in impairments of language functions known as aphasia (Faroqi-Shah & Friedman, 2015). Aphasia causes specific breakdown of communicative functions. Impairments may exist in language components (morphology, phonology, syntax, pragmatics, and semantics), as well as expressive and receptive language in any/all modalities (speaking, understanding, reading, writing, and signing) (Papathanasiou, Coppens, & Potagas, 2013).

Most persons with aphasia (PWAs) retain many linguistic abilities but encounter problems of reduced efficiency of formulation and production of language; reduced access to linguistic information stored in the brain, and limited retention of new linguistic information. Additionally, aphasia is not a disorder of sensation, motor function, or intellect. According to Chapey (2008), aphasia "is characterized by a reduction or impairment in the ability to access language form or structure, language content or meaning, language use or function, and the cognitive processes that underlie and interact with language such as attention, memory, and thinking" (p. 65). Thus, aphasia affects the expression and comprehension of language functions limiting the ability of PWAs to communicate actively and participate in everyday life and impacting their quality of life.

Review of Literature

Auditory comprehension problems of varying severities exist in almost all kinds of aphasia types, and may be influenced by several factors, such as the severity of aphasia, type of aphasia, attention deficits, and phonological deficits (Eom & Jee Eun, 2016). Comprehension of words depends on understanding of phonemes, the smallest meaningful units of sounds in a language. Difficulties accessing and retrieving lexical items may be exacerbated by phonemic comprehension deficits. If one cannot understand a phoneme (the smallest meaningful unit of sound), word comprehension deficits will be present (Bamiou, Musiek, & Luxon, 2003). Thus, auditory comprehension is largely dependently on the ability to break down auditory information into smaller units in order to process language. A variety of traditional cognitive-linguistic therapies and overall language stimulation methods exist that aim to facilitate both auditory comprehension and verbal expression. Such treatments implicitly address auditory processing by virtue of the auditory-verbal nature of the treatment tasks. Many of them do not explicitly address any type of auditory training to promote auditory processing specifically.

Auditory Training

Auditory information is received from the ears, and then communicated to the brain through nerve fibers, known as the auditory pathways. 80% of nerves from the right ear cross over into the left hemisphere. These nerve tracts are known as contralateral pathways. The remaining 20% of nerve tracts from the right ear connect with areas in the right hemisphere, which are known as the ipsilateral pathways. Similarly, 80% of nerves from the left ear cross over to the right hemisphere and 20% continue on into the left hemisphere. These auditory pathways are critical for processing auditory information, especially speech (Martin & Clark, 2006). The understanding of speech relies on the human auditory system's ability to process auditory information that is presented binaurally, or to both ears. This may be targeted with dichotic listening tasks. Dichotic listening tasks consist of listening to different acoustic stimuli that are presented to both ears simultaneously (Musiek & Chermak, 2015).

Following lesions resulting in aphasia, a variety of central auditory processing deficits frequently exist due to involvement of areas in the left hemisphere that are associated with auditory processing (Strauss-Hough, Downs, Cranford, & Givens, 2003). Often, the ear that is contralateral to the site of lesion will show auditory processing deficits (Adriani et al., 2003). These central auditory processing deficits include problems such as identifying and discriminating sounds, perceiving words, and detecting signals in the presence of noise. 49% of individuals who have experienced unilateral cerebrovascular auditory lesions report auditory perceptual problems. Auditory perceptual problems negatively influence PWAs ability to receive and understand auditory messages. One of the most common auditory perceptual problems reported following stroke is difficulty understanding speech in noise (Hurley & Davis, 2011). Auditory processing deficits may be especially prominent in environments with simultaneous speakers and those that require sound localization, and may also have a potentially important functional impact on communication (Bamiou et al., 2012). In one study, PWAs were found to demonstrate considerably more difficulty with processing speech in noise than age-matched controls without aphasia (Rankin, Newton, Parker, & Bruce, 2014). Yet, despite a high prevalence, auditory processing deficits secondary to stroke remain largely unrecognized (Bamiou et al., 2012). Furthermore, though PWAs frequently demonstrate decreased auditory processing abilities, traditional language-based approaches do not explicitly address these deficits.

Traditional speech-language therapies for auditory processing disorders and language deficits in PWAs tap into auditory processing abilities through use of dichotic listening tasks. Therapy is frequently completed through auditory verbal modality, which requires dichotic listening. Dichotic listening tasks involve integration of auditory stimuli from both ears. Additionally, dichotic listening requires both binaural integration (combination of auditory information from both ears) and binaural separation (the ability to attend to auditory stimuli presented in one ear while ignoring stimuli presented to the opposing ear). Dichotic listening is strongly modulated by attention and depends on communication between the right and left hemispheres of the brain. Furthermore, dichotic listening simulates everyday listening situations (Rankin et al., 2014) and is crucial for functional auditory comprehension, attention, and communication (Murphy et al., 2011).

Dichotic listening programs were traditionally implemented with persons with auditory processing disorders to strengthen weakened auditory pathways. More recently, dichotic listening programs have gained attention as a potentially viable treatment for persons with brain injury, as well as PWAs. Auditory language based functions, and overall communication have shown improvement following dichotic listening therapies in persons with weakened auditory pathways secondary to brain damage (Hurley & Davis, 2011).

One such dichotic listening program, dichotic interaural intensity difference training (DIID), improves dichotic processing in individuals with a variety of disorders accompanied by auditory processing difficulties (Moncrieff & Wertz, 2008; Musiek & Schochat, 1998; Musiek, Baran, & Shinn, 2004). DIID first reduces the suppression of the weaker auditory pathway, and then strengthens the connections in the weaker auditory pathway through exposure to increasingly challenging listening conditions. This is completed through dichotic listening tasks in which the intensity of stimuli presented to the stronger ear is gradually decreased, while the intensity of stimuli presented to the weaker ear is increased (Geffner & Ross-Swain, 2012).

DIID training has shown a positive effect on communication abilities of persons with traumatic brain injury (TBI). TBI patients who participated in the training reported increase in participation of daily activities, such as talking on the phone (Musiek, Baran, & Shinn, 2004), and an increase in neural synchrony and a greater number of neural responses as measured by electrophysiological measures (Murphy et al., 2011). However, there is limited evidence that supports the use of auditory process training to improve overall language and lexical processing abilities.

One specific dichotic listening auditory training program based upon DIID, Constraint Induced Auditory Training (CIAT), has gained attention in recent years (Hurley & Davis, 2011). CIAT is a dichotic listening program that is designed to strengthen auditory processing of the weaker auditory pathways through listening tasks. The creation of CIAT was inspired from constraint-induced movement therapy (CIMT), which was established on the premise that limb movements in patients with chronic stroke and hemiplegia could be modified with intensive training over a short period of time (Hurley & Davis, 2011). CIMT centers on actively constraining the less impaired limb to counteract the potential for learned nonuse of the impaired limb. The large body of evidence supporting CIMT encouraged investigators to expand the scope of constraint-induced therapies to other areas of stroke rehabilitation, including aphasia (Cherney, et al., 2008).

Through dichotic listening tasks, CIAT targets the weaker ear in order to strengthen the auditory pathways involved in auditory processing (Hurley & Davis, 2011). The strengthening of neural pathways is explained by the principles of neuroplasticity. Neuroplasticity is the ability of the brain to change and reorganize connections, often in response to learning or new experiences (Efrati et al., 2013). This also explains how the brain retains a lifelong capacity to adapt and reorganize itself. Through a deficit specific program, such as CIAT, the brain can increase synapses and neural density in damaged areas. This allows other portions of the brain to assume functions of the damaged areas (Hurley & Davis, 2011). With CIAT, the damaged portion of the auditory pathway is forced into activation while the dominant, stronger pathway is constrained (Hurley & Davis, 2011). It is postulated that deficits in PWAs may result from compromised cognitive processes other than language that interact with the language processing system. Auditory attention deficits are the most frequently observed cognitive processing deficits following stroke (Barker-Collo et al., 2009). Additionally, variability in deficits of PWAs may be attributed to attention allocation deficits, as opposed to purely linguistic deficits (Arvedson & McNeil, 1987; Tseng, McNeil, & Milenkovic, 1993). By strengthening the weaker auditory pathway in PWAs, overall language-processing abilities may be increased (Hurley & Davis, 2011).

Although a limited amount of research on CIAT exists, preliminary results are promising. Hurley and Davis (2011) documented results of CIAT on two PWAs following use of CIAT. In one case, a PWA who had difficulty understanding speech (especially with competing signals), a weaker right auditory pathway, and a left ear advantage experienced positive results following CIAT treatment. Following ten treatment sessions, the PWA's dichotic listening abilities were determined to be within normal limits, binaural integration performance improved, and electrophysiological activity in the damaged auditory processing areas increased. Additionally, the PWA noted many perceptual improvements.

A second PWA who underwent eight CIAT sessions also demonstrated marked improvement in listening abilities. Prior to CIAT, the PWA scored 0% on right dichotic listening tasks. The PWA's dichotic scores increased to >80% accuracy on the right ear dichotic listening tasks following CIAT treatment. The PWA's spouse also reported subjective improvements in the PWA's everyday listening skills, which included increased comprehension and participation in activities of daily living. Though language was not formally assessed in the above studies, the results suggest that CIAT strengthened patients' auditory processing abilities, which are crucial for comprehension and production of language, as previously described. These results are positive, yet inconclusive due to the lack of evidence on the overall effectiveness of CIAT in PWAs. With further research, the effectiveness of CIAT on PWAs may be determined. Unlike CIAT, cognitive-linguistic therapies have a large base of evidence for increasing language and overall communication abilities in PWAs.

Traditional Cognitive-Linguistic Therapy

Traditional cognitive-linguistic therapies have been successful in increasing overall language abilities in PWAs. Cognitive-linguistic therapies center on the restoration of linguistic deficits through stimulating the brain's linguistic cortical network. These networks that are targeted are responsible for semantics, phonology, or syntax (De Jong-Hagelstein et al., 2011).

Cognitive-linguistic therapy is recommended during both acute and post-acute rehabilitation phases for language impairments following a left hemisphere stroke (Cicerone et al., 2005). The specific cognitive-linguistic therapy that is implemented depends on the patient's deficits.

Speech in individuals with Broca's aphasia is characterized as telegraphic. It is effortful and halting, with omission of articles, prepositions, function words, and inflectional word endings (DeLong et al., 2015) and is frequently limited to content words (Gleason, Goodglass, Green, Ackerman, & Hyde, 1975). Deficits in Broca's aphasia have been addressed using various treatment methods, many of which target lexical-semantic relations, verb retrieval, and/or comprehension and expression of complex sentences (DeLong et al., 2015). Furthermore, comprehension of syntactically complex sentences (e.g. passive and object relatives), especially in semantically reversible contexts, is frequently targeted (Faroqi-Shah & Friedman, 2015). Semantically reversible sentences are those where the agent (subject) and patient (person/object being acted upon) of the sentence may be placed in reverse order while still retaining meaning. For example, "the boy races the little girl" can be changed to "the little girl races the boy" and it would still convey a meaningful message (Richardson, Thomas, & Price, 2010), unlike in a non-reversible agent-patient construction, where the patient can never occupy an agent's position (e.g. The apple ate the boy).

One cognitive-linguistic treatment method used to remediate sentence level deficits in Broca's aphasia is the Treatment of Underlying Forms (TUF) (Thompson, 2001). TUF is a linguistic specific approach in which the client is trained in production of complex, non-canonical sentence structures. The ability to formulate non-canonical sentences is crucial for English speakers to emphasize the various elements in a sentence structure. For example, if the emphasis has to be placed on the object of a sentence, it can be moved to the initial part of the sentence leading to an active-cleft sentence (e.g. “it was the girl who the dog chased.”). PWAs, specifically those with Broca’s aphasia, have trouble assigning thematic roles to arguments that are not in canonical position. Therefore, a PWA with Broca’s aphasia would attribute the role of ‘agent’ (subject) to the girl in the previous example. Remediation of this area of deficit is addressed by TUF. PWAs who are appropriate for TUF include those who (1) exhibit agrammatic speech, (2) have asyntactic comprehension (understand canonical sentence forms better than non-canonical sentences), (3) have retained verb comprehension but exhibit difficulty in producing verbs in constrained sentences, (4) and have impaired production of sentences that are not canonical (Thompson, 2001).

TUF is a departure from traditional sentence-level treatments in that TUF initially trains complex sentence forms rather than simpler sentence forms. This order of training is implemented to promote generalization from complex to simple sentences. Additionally, generalizations of sentences that are linguistically similar are also predicted (similar verbs and movement operations) (Thompson, 2001).

The development of TUF was based on three theoretical principles: (1) Verbs and their arguments influence sentence production and comprehension, (2) there is a distinction between arguments and adjuncts, and (3) the formation of non-canonical sentences. A majority of sentences are representations of relations between verbs and their arguments (Thompson, 2001). The verb is a central component of a sentence since it determines which arguments will be present. When verbs are learned, the verb arguments are also learned. This means that the argument structure becomes part of the lexical entry of the verb. For example, the verb “eat” has to be followed by an edible item. Arguments are typically noun phrases or prepositional phrases that take the argument position (usually subject, object, and indirect object position) (Thompson, Shapiro, Li, & Schendel, 1995).

Likewise, verb arguments are obligatory to maintain grammaticality. Sentence processing and production are affected by a verb's argument structure. Both normal subjects and PWAs appear to access thematic representations when the verb of a sentence is heard. Consider the sentence "John hit the ball." John is the person completing the action and is attributed with the thematic role of the agent. The verb "hit" requires that two arguments be present to maintain grammaticality (i.e. *who* hit *what*). The ball is the entity that is receiving the action and takes on the role of the receiver. These arguments are obligatory when the verb "hit" is used in order to form a grammatically correct sentence (Thompson, 2001).

Before training complex sentences, intervention in TUF begins by establishing a foundation, which is the basis for treatment. First, establishing and improving receptive and expressive language through training of verbs and lexical units in a typical canonical sentence order (e.g. "the dog chased the girl") is emphasized. Next, procedures to form complex sentences are trained (Thompson, 2001). It is common for PWA with Broca's aphasia to use and generalize their knowledge of probabilities in selecting an "agent-first" strategy in which the first noun phrase encountered is mistakenly interpreted as the agent of the sentence. Consistent with this view, many PWAs will exhibit relatively unimpaired comprehension of canonical sentences (Grodzinsky, 2000). In TUF, sentences used in treatment and for generalization are carefully selected based on lexical and syntactic properties. The verb types and syntactic movement required to form target sentences are controlled, to enable understanding and use of non-canonical sentences.

Grammatical changes in discourse have been apparent in PWA after TUF training. A decrease in the proportion of simple sentence productions and an increase in complex sentences have been noted. Additionally, an increase in mean length of utterance (MLU) has been reported (Thompson, 2001). MLU is a metric used to measure average phrase length, which is dependent on the number of morphemes used in each utterance (Brown, 1973). Additionally, an increased frequency of verbs and their correct usage are observed resulting from TUF (Thompson, 2001).

Evidence of neurobehavioral changes is also apparent following TUF. Magnetic resonance imaging (MRI) of PWA after TUF training has revealed increased brain activation in the right hemisphere homologue of Wernicke’s area and an increased hemodynamic (increased blood flow) response in left perilesional (regions around the damaged site) hemisphere areas (Thompson, 2001). Similarly, Grodzinsky (2000) suggested that surrounding areas of Broca’s area (operculum, insula, subjacent white matter) play a highly specific role in grammatical transformation ability. For this reason, therapeutic intervention targeting syntactic manipulation is thought to strengthen neural connections in and around Broca’s area.

A number of studies have supported the use of high complexity sentence training to promote generalization to simpler sentences (Love, Swinney, Walenski, & Zurif, 2008; Thompson, Shapiro, Tait, Jacobs, & Schneider, 1996; Thompson & Shapiro, 1994; Thompson, Ballard, & Shapiro, 1998; Ballard & Thompson, 1999). Furthermore, Thompson, Kiran, Sobecks, and Shapiro (2003) trained two participants with the less complex structures first (who-questions), while two participants were trained with the more complex form (object-relative) first.

The group that received complex training first resulted in robust generalization for linguistically similar structures as well as simpler constructions (who-questions).

Statement of Purpose

There is a substantial amount of empirical support for cognitive-linguistic therapy in remediating language deficits following a left hemisphere stroke (Cicerone et al., 2005). TUF, a cognitive-linguistic therapy, increases both sentence-level comprehension and expression in PWAs with agrammatism through the manipulation of canonical sentences into more complex, non-canonical sentence forms (Thompson, 2001). Traditional cognitive-linguistic therapy approaches address restoration of linguistic components, but fail to explicitly target auditory processing deficits that are frequently present post-stroke. These auditory processing deficits may impact therapy outcomes, as language treatments are most commonly delivered in the auditory-verbal modality. Additionally, PWAs with concomitant cognitive deficits, including attention deficits, have been found less likely to benefit from aphasia treatment than those without co-existing cognitive deficits (Goldenberg, Dettmers, Grothe, & Spatt, 1994; Murray, Ballard, & Karcher, 2004).

CIAT, a program that explicitly addresses auditory processing, has resulted in strengthened auditory pathways in PWAs (Hurley & Davis, 2011). Though limited evidence for CIAT's use with PWAs exists, preliminary results are promising. A recent study using CIAT and treatment of Verbs using a cognitive-linguistic therapy known as VNeST showed promising outcomes in the overall language comprehension and expression of a PWA (Rangamani and Roegner, 2016). Yet, until now, there are no known studies that outline the effects of combined TUF and CIAT treatments on overall language abilities in PWAs. For this reason, and to further the results of the previous study by Rangamani and Roegner (2016), the following study was completed with the objective of determining the differences in functional communication outcomes of a PWA under two conditions:

1. Cognitive-linguistic therapy (TUF), conducted in isolation and
2. Cognitive-linguistic therapy (TUF) carried out in combination with auditory process training (CIAT).

The following null hypothesis was targeted: The use of TUF in combination with CIAT will yield no significant gains in overall language abilities and communication, as compared to TUF treatment used in isolation.

Chapter II: Methodology

This study aimed to examine the differences in treatment and functional communication outcomes in a PWA under two conditions: (1) Treatment of Underlying Forms Therapy (TUF) conducted in isolation and (2) TUF in carried out in combination with Constraint Induced Auditory Training (CIAT). Based on the results of previous research studies, the following null hypothesis was proposed:

TUF, when used in combination with CIAT will yield no significant changes in the overall treatment and functional communication outcomes of a PWA, as compared to TUF treatment conducted in isolation.

Subject

A 74-year-old female stroke survivor with aphasia was the participant in this study. The participant's medical records indicated that she experienced a left cerebrovascular accident (CVA, or commonly known as stroke) 3.5 years prior to the study that resulted in expressive aphasia and right upper extremity weakness. The fact that the participant was past six months post-onset of her stroke ensures that any change following therapy is not due to spontaneous recovery, which is known to occur within the first six months of an onset of stroke (Basso, 1992). The participant received language therapy services through a university speech-language and hearing clinic for one and a half years before the commencement of this study.

The participant and her power of attorney (POA) were provided with a document detailing the present study's procedures and therapy components, which were approved by the St. Cloud State University's Institutional Review Board (IRB) prior to the start of this study. The participant's POA also completed an informed consent approved by the IRB (See Appendix B).

The participant and her family were both highly motivated to participate in speech-language therapy and this study.

At the start of this study, the participant exhibited agrammatic speech with stereotyped utterances and moderate comprehension deficits, as identified by the *Western Aphasia Battery-Revised* (WAB-R) (Kertesz, 2006). The participant wore hearing aids during each treatment session, as the participant had symmetrical bilateral sensorineural hearing loss from 1000-8000 Hz. The participant's hearing aids were checked for proper functioning prior to each treatment session.

Experimental Design

A single-case study with multiple baselines in an A1BA2CA3 format was implemented in this study. Single-subject designs are ideal for studying PWAs, and are frequently encountered in the field of communication sciences and disorders, for a variety of reasons. Symptomology of communication deficits in PWAs are often diverse and may present differently between PWAs. Traditional group designs may not be feasible to use with PWAs due to the diverse range of impairments and differences in PWAs (Byiers, Reichle, & Symons, 2012). Additionally, the single-subject design is a useful tool for investigating viability of treatment before large-scale, randomized controlled trials are used to further investigate treatment implications. In large-scale studies, treatment effects are often implied to be efficacious for most or all participants used in the study. This is not a valid assumption to make for PWAs since impairments and differences between PWAs are often not generalizable between individuals. Conversely, single case designs provide evidence for treatment efficacy at the individual level, which takes evidence-based practice into account. Furthermore, the internal validity of the study is strengthened when a single-subject design is used (Byiers et al., 2012). Lastly, external validity of single-subjects designs can be established through study replication involving different participants to establish if generalizability exists (Byiers et al., 2012). Thus, the present study focused on treatment effectiveness of two different procedures in a single participant.

Treatment was carried out over a total of 26 weeks with treatment performed during two 8-week blocks. The first block consisted of TUF in isolation, and the second block included both TUF and CIAT. Treatment was carried out two days per week for 1.0 to 1.5 hours per day in order to optimize the effectiveness of therapy since various studies suggest that the intensity of therapy is a key factor in recovery (Godecke et al., 2013; Robey, 1998).

TUF was implemented in one-hour sessions and CIAT was carried out in half-hour sessions. During Block 1, TUF was completed in 1-hour sessions, twice per week for 8 weeks while Block 2 (TUF used in conjunction with CIAT) of treatment consisted of two, 1.5-hour sessions per week for eight weeks. There was a two-week washout period between Blocks 1 and 2. During Block 2, the presentation order of TUF and CIAT were alternated between sessions to prevent any order effects within treatment sessions.

Standardized Assessments

Both Standardized and criterion-referenced assessments were administered before and after each treatment block. The participant's nature and severity of language impairments were measured using standardized measures before and after each block of treatment. Assessments administered included the WAB-R (Kertesz, 2006), the *Verb and Sentence Test* (VAST) (Bastiaanse, Edwards, & Rispens, 2002), and the *Northwestern Assessment of Verbs and Sentences* (NAVS) (Thompson, 2011). Assessment results are listed in Table 1.

The WAB-R is a widely used instrument that assesses linguistic skills that are frequently affected in PWAs, in addition to nonlinguistic skills. Differential diagnosis information is also provided by the WAB-R. The WAB-R has high internal consistency measures, test-retest reliability, and temporal reliability. Additionally, high inter- and intra-judge reliability and strong content, face, and construct validity have been established with the WAB-R (Shewan & Kertesz, 1980). An Aphasia Quotient was obtained through administration of the Spontaneous Speech, Auditory Verbal Comprehension, Repetition, and Naming and Word Finding subtests on the WAB-R. The Aphasia Quotient is a measure of the functional severity of language disturbance and serves as a numerical measurement for the effect of therapy (Kertesz & Poole, 1974).

The VAST is an assessment that examines verb and sentence processing and pinpoints underlying deficits at the sentence level in aphasia. The framework for the VAST centers on three processes that are related to comprehension and production: 1. The recognition of verbs in regard to meaning, thematic roles, and argument structure; 2. The grammatical structure of verbs; 3. Integrating grammatical properties onto semantic properties (Bastiaanse, Edwards, Mass & Rispens, 2003). The Sentence Comprehension subtest was the only subtest that was administered for the purpose of this study.

The NAVS is an assessment that is designed to examine syntactic deficits in aphasia. Subtests include tests for verb naming and comprehension, verb argument structure production structure in simple, active sentences, and the production and comprehension of canonical and non-canonical sentences (Cho-Reyes & Thompson, 2012). For the purpose of this study, the Verb Naming Test, Verb Comprehension Test, and Argument Structure Production Test subtests were administered to the participant.

Criterion-Referenced/Functional Measures

While norm-referenced measurements identify an individual's performance in relation to others on the same measure, criterion-referenced measures examines changes in performance with respect to an established standard of performance (Popham & Husek, 1969). Criterion-referenced measures allows for comparison between pre-therapy and post-therapy performance on non-standardized language tasks in PWAs (McCauley & Swisher, 1984). A number of measures, including discourse analysis, quality of life rating scales, and the *Arizona Battery for Reading and Spelling* were used as criterion referenced assessments in the study.

A variety of discourse samples were collected throughout the present study. Discourse sampling allows the PWA to use holistic processing to create unrestricted communicative responses (Chapman, Highley, & Thompson, 1998). They also provide an opportunity to examine the PWA's communication skills in an unstructured context that closely resembles functional communication in everyday life. Before and after each block of treatment, the participant's verbal expression skills were examined through procedural discourse (description of steps to make a peanut butter and jelly sandwich), narrative discourse (retell a short story), and picture description (picture scene from the WAB-R) tasks. Discourse samples were collected and analyzed according to principles discussed in Nicholas and Brookshire (1993). Each discourse sample was recorded, timed, and transcribed prior to analyses. Discourse analyses examined number of words, words per minute, number of correct information units (CIUs), CIUs per minute and percent CIUs. CIUs are derived from counting words that are intelligible, accurate, relevant and informative about the conversation topic but do not have to be grammatically correct (Nicholas & Brookshire, 1993). CIUs are used to evaluate the informativeness and efficiency of connected speech. Furthermore, CIUs provide an overall description of how the participant functions in conversation. CIUs per minute can be calculated by counting CIUs and dividing by the minutes they occurred in. Percent CIUs are calculated by dividing the total number of words produced by the number of CIUs.

The *American Speech-Language-Hearing Association Quality of Communication Life Scale* (ASHA QCL) was used to measure the participant's perception of quality of life in relation to communication. The ASHA QCL is composed of eighteen statements that require the PWA to select the degree to which they agree or disagree with statements that relate to the impact of a communication disorder on psychosocial wellbeing, vocational/education impacts, and overall quality of life (e.g. "I like to talk with people."). Responses are recorded on a 5-point visual analogue scale in which (1) corresponds to "No" and (5) to "Yes." Responses are translated to numerical values and averaged. Average scores range from 1 (low) to 5 (high), with a higher score indicative of a greater quality of communication life. This assessment allows for measurement of changes in the patient's perception of quality of life in relation to his/her communication disorder over the course of the study (Paul et al., 2004).

The *Arizona Battery for Reading and Spelling* (ABRS) (Beeson & Rising, 2010) was used in the present study as a control variable. The ABRS is a 100-item word list that is used to test single-word reading and spelling. It examines both regular and irregular spelled words as well as spelling of non-words. Number of letters, frequency of the words, and the types of errors made are analyzed by the ABRS. The ABRS requires the examiner to read target words aloud to the participant. The participant is then instructed to repeat the target word and record it on paper (Beeson & Rising, 2010). The participant was administered Spelling List 1 (real words) and the

ABRS Non-words Spelling List for the purpose of this study. No change in spelling ability was hypothesized since therapy did not address this modality.

Experimental Stimuli

CIAT:

Explicit auditory training was conducted using CIAT's dichotic "three syllable sentences" Forms A and B (Hurley & Davis, 2011). The CIAT program includes compact discs with auditory training tracks, response recording forms, and an examiner-training manual. For this portion of the study, the participant's hearing aids were removed and headphones were worn. Volume of headphones was adjusted to a sufficiently loud but comfortable level, as indicated by the participant. Auditory stimuli were presented through headphones and the participant was asked to repeat sentences presented to the right ear, while ignoring the ones in her left ear. For example, a stimulus set such as "the cat slept" was played in the right headphone, while "he ran fast" was played in the left headphone. For a correct response, the participant had to repeat, "the cat slept." A response time of 10 seconds for each presentation was given. Participant responses were recorded on the response recording forms that accompanied the CIAT program. The CIAT program consists of two Forms. Form A is composed of 25 pairs of "three syllable sentences" sentences while Form B consists of 12 pairs of "three syllable sentences" and is located on a separate audio track. See Appendix C for a list of dichotic sentences. A cuing hierarchy was implemented when the participant failed to repeat or respond correctly. The cuing hierarchy aimed to assist the participant to be successful in repeating auditory stimuli presented to the right ear. The cuing hierarchy included repetition of audio tracks, written cues, an earplug for the left ear to dampen the left ear signal, and slight removal of the left headphone so the client could access the auditory signal played to the right ear. A model of the cuing hierarchy is detailed in Appendix E.

Verb Stimuli:

Cognitive-linguistic therapy was completed using Treatment of Underlying Forms (TUF). A list of 40 verbs that target production of sentences that are semantically reversible was created and divided into four lists of 10 verbs each. Semantically reversible sentences are those where the agent (subject) and theme (person/object being acted upon) of the sentence may be placed in reverse order while still retaining semanticity (e.g. “the boy races the girl” vs. “the girl races the boy”). List 1 and List 2 were used as treatment lists during blocks 1 and 2, respectively. List 3 was used as a probe list. A probe list is implemented periodically throughout the treatment in order to measure any generalization of treatment effects on untrained items. List 4 was used as a separate generalization list to examine whether treatment effects were generalizing to untrained verbs. This separate generalization list was included to rule out any practice effects that could occur on repeated exposure of probe items that were used to measure on-going generalization. Attempts to minimize teaching of test items were made by limiting overlap of targeted verbs that are on the VAST and NAVS. Due to the limited number of verbs that target semantically reversible sentences, 5 out of the 40 verbs in the four lists overlapped with verbs that are on the VAST. However, none of the verbs on the four lists overlapped with the NAVS. Colored action photographs were used to elicit sentence production during pre-post measurements and while performing TUF. A complete list of 40 verbs and a sample of the action photographs are provided in Appendix D. All four lists were tested before and after each block of treatment for measuring baseline and treatment outcomes.

Treatment

CIAT:

CIAT sessions were carried out using a portable music-playing device and headphones. A portable music player was used instead of a CD player since keeping consistency of volume levels and navigating audio tracks was more easily completed on the portable music player. The participant used the same pair of headphones during each CIAT session in order to minimize potential variability between headphones. Prior to each session, the participant's headphones were tested by the researcher to ensure proper functioning. Each session, maximum volume level was implemented. This intensity was chosen since the participant rated the volume level as consistently comfortable. The participant was instructed to repeat sentences presented to the right ear while suppressing the competing sentence presented to the left ear. The right ear was targeted since it is contralateral to the site of lesion and was the weak ear, as discussed earlier.

TUF:

At the start of each treatment session, the participant was instructed to describe an action by forming complete, active sentences when presented with color photographs corresponding to the ten treatment verbs. A response time of fifteen seconds was given after each presentation of an action verb. Responses were counted as correct when the appropriate agent, action, and theme corresponding to the pictures were named. List 1 was implemented during Block 1 of treatment, while List 2 was targeted in Block 2. Verbs to be targeted during each treatment session were assigned a number and randomized using an online random number generator prior to start of each session.

Constructions of complete, active sentences were targeted through the TUF protocol. A cueing hierarchy was implemented to aid in obtaining target responses from the participant, which included naming the agent, action and the theme. Cueing included written first letter cues, phonemic cues, written anagrams in a field of three choices, and direct models. Additionally, choral reading and repetition of target sentences were implemented to facilitate fluency.

Training of sentences began by showing the participant an action picture and instructing her to form a complete sentence corresponding to the picture. The researcher also provided the participant with cue cards labeled [Who?] [Action] and [To Whom?] to prompt a three-part response from the participant. Following a correct response, the participant was instructed to identify the focus of the sentence by placing a “Focus” cue card above the agent card of the sentence. Then, the participant read the sentence aloud.

Next, the participant was instructed to create a passive, object-cleft sentence that retains the same meaning as the active sentence by shifting the focus from the agent to the theme of the sentence. Cue cards labeled [it was], [who was], and [by] were given to the participant to construct the sentence. For example, the sentence “[The nurse] [measured] [the boy]” would be transformed into “[It was] [the boy] [who was] [measured] [by] [the nurse].” Following creation of the passive sentence, the participant was prompted to read the sentence aloud and again identify the agent, action, and theme of the sentence. Then, the participant was instructed to transform the passive sentence back to its original active form that was initially created (e.g. [The nurse] [measured] [the boy]). The participant then read the sentence aloud.

Next, the participant was asked to judge the semantic accuracy of ten sentences pertaining to the target sentence. These sentences were semantically and/or syntactically similar to the target sentence and were created by substituting incorrect agents, actions and/or themes. The participant was asked to judge the accuracy of the sentences when read aloud. Depending on whether the judgment sentence retained the same meaning as the original target sentence, the participant was instructed to give a “yes” or “no” response. When incorrect responses were provided, the researcher provided verbal feedback and explanation to correct judgment errors. For example, for the target sentence “the nurse measures the boy,” judgment statements consisted of sentences such as “the doctor measured the boy”, “it was the boy who was measured by the nurse”, “the nurse measures the boy”, etc.

The number of sentences targeted per session increased as the participant became increasingly familiar with sentence arguments. At the start of treatment, the participant was able to complete all the steps for only one to two target sentences per session. As the participant became familiar with the steps and processes of treatment, four to five target sentences from the treatment list were consistently completed.

Probes and Generalization:

List 3 (Probe List) was administered halfway through both Blocks 1 and 2 to determine if any generalization to untrained sentences was occurring. The client was solely exposed to the Probe List at the start, middle, and end of each block. List 4 (Generalization List) was administered exclusively at the start and end of Block 1, and the end of Block two to rule out any possible practice effects on the probe list from repeated exposure to stimuli.

In conclusion, this study examined the effect of TUF and CIAT treatments that were provided in two, 8-week blocks, with a two-week washout period between blocks. TUF was used in isolation during the first block, while TUF and CIAT were both implemented in the second block. Standardized and criterion-referenced assessments were administered at the start and end of each treatment block. Two untrained probe and generalization lists were administered to measure any generalization of treatment effects. All participant responses were recorded and analyzed. The results section details this information.

Chapter III: Results

The primary objective of the study was to examine the differences in treatment and functional communication outcomes in a PWA under two conditions:

1. Cognitive-linguistic therapy (TUF) in isolation, and
2. Cognitive-linguistic therapy (TUF) in combination with auditory process training (CIAT).

The following null hypothesis was postulated: The use of TUF in combination with CIAT will yield no significant gains in overall language abilities and communication, as compared to TUF treatment used in isolation.

Treatment for language expression and comprehension was completed in two eight-week blocks, for a total of 16 hours per treatment block. Specifically, cognitive-linguistic therapy was completed in one-hour sessions, two times per week during both treatment blocks. Additional auditory training was completed using CIAT for 30 minutes every session only during Block 2. Results from all standardized assessments, criterion-referenced assessments and treatment outcomes are detailed below.

Standardized Assessment Measures

Standardized tests were administered before and after both treatment blocks in order to quantify the nature and severity of language impairments and any progress following therapy. These tests included *The Western Aphasia Battery – Revised, Verb and Sentence Test, and Northwestern Assessment of Verbs and Sentences.* The results, intra-rater, and inter-rater reliability scores for these assessments are shown in Tables 1-9.

Table 1

Results from the WAB-R

WAB-R*	Pre-/Post Block 1	Pre-/Post Block 2	Pre-Post Therapy (Overall)	Maintenance (3 months post-Block 2)
Spontaneous speech	8/9 (+5%) (p=.749)	9/11 (+10%) (p=.525)	8/11 (+15%) (p=.525)	11/12 (+5%) (p=.749)
Information content	4/5 (+10%) (p=.153)	**5/7 (+20%) p<.01 (p=.003)**	**4/7 (+30%) p<.01 (p=.000)**	7/8 (+10%) (p=.100)
Fluency, grammar, paraphasias	4/4 (0%) (p=1.00)	4/4 (0%) (p=1.00)	4/4 (0%) (p=1.00)	4/4 (0%) (p=1.00)
Auditory/verbal comprehension	163/166 (+1.5%) (p=.695)	**166/142 (-12%) p<.05 (p=.006)**	**163/142 (-10.5%) p<.05 (p=.013)**	142/155 (+6.5%) (p=.136)
Yes/no questions	60/60 (0%) (p=1.00)	60/57 (-5%) (p=.076)	60/57 (-5%) (p=.076)	57/57 (0%) (p=1.00)
Auditory word recognition	55/56 (+1.7%) (p=.729)	56/53 (-5%) (p=.341)	55/53 (+3.4%) (p=.542)	53/53 (0%) (p=1.00)
Following sequential commands	48/50 (+2.5%) (p=.745)	**50/32 (-22.5%) p<.01(p=.003)**	**48/32 (-20%) (p=.010)**	**32/45 (+16.3%) p<.05(p=.037)**
Repetition	62/58 (-4%) (p=.563)	58/70 (+12%) (p=.075)	62/70 (+8%) (p=.231)	70/60 (-10%) (p=.136)
Naming and word finding	68/62 (-6%) (p=.373)	62/70 (+8%) (p=.231)	68/70 (+2%) (p=.760)	70/60 (-10%) (p=.136)
Object naming	47/45 (-3.3%) (p=.666)	45/51 (+10%) (p=.168)	47/51 (+6.7%) (p=.344)	51/45 (-10%) (.168)
Word fluency	6/5 (-5%) (p=.428)	5/3 (-10%) (p=.075)	**6/3 (-15%) (p=.010)**	3/3 (0%) (p=1.00)
Sentence completion	**9/8 (-10%) p<.05(p=.046)**	**8/10 (+20%) p<.01(p=.000)**	**9/10 (+10%) p<.01(p=.001)**	10/10 (0%) (p=1.00)
Responsive speech	**6/4 (-20%) p<.01(p=.004)**	**4/6 (+20%) (p=.004)**	6/6 (0%) (p=1.00)	**6/2 (-40%) p<.01(p=.000)**
Aphasia Quotient	58.3/58.6 (+.3)	**58.6/64.2 (+5.6)**	**58.3/64.2 (+5.9)**	64.2/63.5 (-0.7)

Table 2

WAB-R Reliability Scores

	Researcher – Rater 1	Rater 1 – Rater 2	Researcher – Rater 2
Pre-Block 1			
Spontaneous Speech	z=0.00, p=1.00	z=0.00, p=1.00	z=0.00, p=1.00
A/V comprehension	z=-.26, p=.795	z=.13, p=.896	z=-.13, p=.897
Repetition	z=.15, p=.884	z=-.15, p=.884	z=0.00, p=1.00
Naming	z=-.15, p=.879	z=.30, p=.762	z=.15, p=.880
Aphasia quotient	z=-.09, p=.928	z=.14, p=.892	z=.05, p=.964
Post-Block 1/Pre-Block 2			
Spontaneous Speech	z=0.00, p=1.00	z=0.00, p=1.00	z=0.00, p=1.00
A/V comprehension	z=0.00, p=1.00	z=-.13, p=.893	z=-.13, p=.893
Repetition	z=0.00, p=1.00	z=0.00, p=1.00	z=0.00, p=1.00
Naming	z=0.00, p=1.00	z=0.00, p=1.00	z=0.00, p=1.00
Aphasia quotient	z=0.00, p=1.00	z=-.05, p=.964	z=-.05, p=.964
Post-Block 2			
Spontaneous Speech	z=0.00, p=1.00	z=0.00, p=1.00	z=0.00, p=1.00
A/V comprehension	z=.11, p=.912	z=.11, p=.913	z=.22, p=.826
Repetition	z=0.00, p=1.00	z=-.16, p=.877	z=-.16, p=.877
Naming	z=0.00, p=1.00	z=0.00, p=1.00	z=0.00, p=1.00
Aphasia quotient	z=.05, p=.963	z=-.05, p=.963	z=0.00, p=1.00
Maintenance			
Spontaneous Speech	z=0.00, p=1.00	z=0.00, p=1.00	z=0.00, p=1.00
A/V comprehension	z=-.12, p=.904	z=.12, p=.904	z=0.00, p=1.00
Repetition	z=0.00, p=1.00	z=0.00, p=1.00	z=0.00, p=1.00
Naming	z=-.14, p=.885	z=-.14, p=.885	z=0.00, p=1.00
Aphasia quotient	z=-.14, p=.889	z=.14, p=.889	z=0.00, p=1.00

*p-values greater than .05 indicate consistency between ratings

Table 3

Results from the VAST Sentence Comprehension Subtest

VAST Subtest	Pre-/Post Block 1	Pre-/Post Block 2	Pre-Post Therapy (Overall)	Maintenance (3 months post-Block 2)
Sentence Comprehension	27/28 (+2.5%) ($p=.879$)	28/32 (+10%) ($p=.141$)	27/32 (+12.5%) ($p=.076$)	32/28 (-10%) ($p=.141$)
Canonical	**12/15 (+15%) $p<.05$($p=.034$)**	**15/18 (+15%) $p<.01$($p=.009$)**	**12/18 (+30%) $p<.01$($p=.000$)**	**18/15 (-15%) $p<.01$($p=.009$)**
Actives	**5/7 (+20%) $p<.01$($p=.006$)**	7/8 (+10%) ($p=.141$)	**5/8 (+30%) $p<.01$($p=.000$)**	8/7 (-10%) ($p=.141$)
Subject Clefts	7/8 (+10%) ($p=.141$)	**8/10 (+20%) $p<.01$($p=.000$)**	**7/10 (+30%) $p<.01$($p=.000$)**	**10/8 (-20%) $p<.01$($p=.000$)**
Non-Canonical	15/13 (-10%) ($p=.165$)	13/14 (+5%) ($p=.546$)	15/14 (-5%) ($p=.527$)	14/13 (-5%) ($p=.546$)
Passive	**8/6 (-20%) $p<.01$($p=.003$)**	6/6 (0%) ($p=1.000$)	**8/6 (-20%) $p<.01$ ($p=.003$)**	6/5 (-10%) ($p=.201$)
Object-Clefts	7/7 (0%) ($p=1.000$)	7/8 (+10%) ($p=.141$)	7/8 (+10%) ($p=.141$)	8/8 (0%) ($p=1.000$)

Table 4

VAST Sentence Comprehension Reliability Scores

	Researcher – Rater 1	Rater 1 – Rater 2	Researcher – Rater 2
	Pre-Block 1		
Sentence Comprehension	z=0.00, p=1.00	z=0.00, p=1.00	z=0.00, p=1.00
Canonical	z=0.00, p=1.00	z=0.00, p=1.00	z=0.00, p=1.00
Non-Canonical	z=0.00, p=1.00	z=0.00, p=1.00	z=0.00, p=1.00
	Post-Block 1/Pre-Block 2		
Sentence Comprehension	z=0.00, p=1.00	z=0.00, p=1.00	z=0.00, p=1.00
Canonical	z=0.00, p=1.00	z=0.00, p=1.00	z=0.00, p=1.00
Non-Canonical	z=0.00, p=1.00	z=0.00, p=1.00	z=0.00, p=1.00
	Post-Block 2		
Sentence Comprehension	z=0.00, p=1.00	z=0.00, p=1.00	z=0.00, p=1.00
Canonical	z=0.00, p=1.00	z=0.00, p=1.00	z=0.00, p=1.00
Non-Canonical	z=0.00, p=1.00	z=0.00, p=1.00	z=0.00, p=1.00
	Maintenance		
Sentence Comprehension	z=0.00, p=1.00	z=0.00, p=1.00	z=0.00, p=1.00
Canonical	z=0.00, p=1.00	z=0.00, p=1.00	z=0.00, p=1.00
Non-Canonical	z=0.00, p=1.00	z=0.00, p=1.00	z=0.00, p=1.00

*p-values greater than .05 indicate consistency between ratings

Table 5

Overall Results from the NAVS

NAVS Subtest	Pre-/Post Block 1	Pre-/Post Block 2	Pre-Post Therapy (Overall)	Maintenance (3 months post-Block 2)
Verb Naming	6/9 (+12.9%) (p=.052)	**9/14 (+22.7%) p<.01(p=.002)**	**6/14 (+36.3%) p<.01(p=.000)**	**14/11 (-13.6%) p<.05(p=.021)**
Verb Comprehension	**16/19 (+13.7%) p<.05(p=.035)**	19/20 (+4.5%) (p=.376)	**16/20 (+18.2%) p<.01(p=.001)**	20/19 (-4.5%) (p=.376)
Argument Structure Production	**2/11 (+28.1%) p<.01(p=.000)**	**11/20 (+28.1%) p<.01(p=.000)**	**2/20 (+56.2%) p<.01(p=.000)**	**20/5 (-46.9%) p<.01 (p=.000)**

Table 6

NAVS Reliability Scores

	Researcher – Rater 1	**Rater 1 – Rater 2**	**Researcher – Rater 2**
Pre-Block 1			
Verb naming	z=.35, p=.727	z=-.35, p=.727	z=0.00, p=1.00
Verb comp.	z=0.00, p=1.00	z=0.00, p=1.00	z=0.00, p=1.00
Argument structure	z=0.00, p=1.00	z=0.00, p=1.00	z=0.00, p=1.00
Post-Block 1/Pre-Block 2			
Verb naming	z=0.00, p=1.00	z=0.00, p=1.00	z=0.00, p=1.00
Verb comp.	z=0.00, p=1.00	z=0.00, p=1.00	z=0.00, p=1.00
Argument structure	z=.27, p=.79	z=-.27, p=.790	z=0.00, p=1.00
Post-Block 2			
Verb naming	z=0.00, p=1.00	z=0.00, p=1.00	z=0.00, p=1.00
Verb comp.	z=0.00, p=1.00	z=0.00, p=1.00	z=0.00, p=1.00
Argument structure	z=.26, p=.798	z=.26, p=.798	z=0.00, p=1.00
Maintenance			
Verb naming	z=0.00, p=1.00	z=0.00, p=1.00	z=0.00, p=1.00
Verb comp.	z=0.00, p=1.00	z=0.00, p=1.00	z=0.00, p=1.00
Argument structure	z=0.00, p=1.00	z=0.00, p=1.00	z=0.00, p=1.00

*p-values greater than .05 indicate consistency between ratings

Table 7

Results from the NAVS Verb Naming Test

Verb Type	Pre-/Post Block 1	Pre-/Post Block 2	Pre-/Post Therapy (Overall)	Maintenance (3 months post-Block 2
1-Place	**1/3 (+40%) p<.01(p=.000)**	**3/4 (+20%) p<.01(p=.003)**	**1/4 (+60%) p<.01(p=.000)**	**4/3 (-20%) p<.01 (p=.003)**
2-Place	3/4 (+10%) (p=.317)	4/6 (+20%) (p=.072)	**3/6 (+30%) (p=.003)**	6/5 (-10%) (p=.378)
3-Place	2/2 (0%) (p=1.000)	**2/4 (+28.5%) p<.05(p=.014)**	**2/4 (+28.5%) p<.05(p=.014)**	4/3 (-14.2%) (p=.275)
Total Correct	6/9 (+12.9%) (p=.052)	**9/14 (+22.7%) p<.01(p=.002)**	**6/14 (+36.3%) p<.01(p=.000)**	**14/11 (-13.6%) p<.05(p=.021)**

Table 8

Results from the NAVS Verb Comprehension Test

Verb Type	Pre-/Post Block 1	Pre-/Post Block 2	Pre-/Post Therapy (Overall)	Maintenance (3 months post-Block 2
1-Place	5/5 (0%) (p=1.000)	5/5 (0%) (p=1.000)	5/5 (0%) (p=1.000)	5/5 (0%) (p=1.000)
2-Place	**6/9 (+30%) p<.01(p=.000)**	9/9 (0%) (p=1.000)	**6/9 (+30%) p<.01(p=.000)**	9/8 (-10%) (p=.073)
3-Place	5/5 (0%) (p=1.000)	**5/6 (+14.3%) p<.05(p=.015)**	**5/6 (+14.3%) p<.05(p=.015)**	6/6 (0%) (p=1.000)
Total Correct	**16/19 (+13.7%) p<.05(p=.035)**	19/20 (+4.5%) (p=.376)	**16/20 (+18.2%) (p=.001)**	20/19 (-4.5%) (p=.376)

Table 9

Results from the NAVS Argument Structure Production Test

Verb Type	Pre-/Post Block 1	Pre-/Post Block 2	Pre-/Post Therapy (Overall)	Maintenance (3 months post-Block 2
1-Place	**0/2 (+40%) p<.01(p=.000)**	**2/4 (+40%) p<.01(p=.000)**	**0/4 (+80%) p<.01(p=.000)**	**4/1 (-60%) p<.01(p=.000)**
2-Place	**1/6 (+33.3%) p<.01(p=.000)**	**6/13 (+46.7%) p<.01(p=.000)**	**1/13 (+80%) p<.01(p=.000)**	**13/3 (-66.7%) p<.01(p=.000)**
3-Place	1/2 (+8.4%) (p=.086)	2/3 (+8.3%) (p=.224)	**1/3 (+16.7%) p<.01(p=.002)**	**3/1 (-16.7%) p<.01(p=.002)**
Total Correct	**2/11 (+28.1%) p<.01(p=.000)**	**11/20 (+28.1%) p<.01(p=.000)**	**2/20 (+56.2%) p<.01(p=.000)**	**20/5 (-46.9%) p<.01(p=.000)**

Pre-Therapy Measures

WAB-R:

The WAB-R assesses linguistic and nonlinguistic skills frequently affected in PWAs and provides differential diagnosis information. As seen in Table 1, pre-therapy assessment revealed the participant's type of aphasia as Broca's aphasia with an aphasia quotient score of 58.3, which is considered moderately severe (Kertesz, 2006). On the spontaneous speech subtest, the participant achieved a score of "8." The Spontaneous Speech subtest is composed of an information content score and fluency rating, along with scores for grammatical competence, and paraphasias. The participant received a score of "4" out of "10" on both the information content and fluency subtests, respectively. According to the WAB-R, this indicates that the participant primarily used halting, telegraphic speech and experienced word-finding difficulties (Kertesz, 2006).

On the Auditory-Verbal Comprehension subtest, the participant achieved an overall score of "163" out of "200." Auditory-Verbal Comprehension measures understanding of yes and no questions, auditory word recognition, and following sequential commands. The participant scored "62" out of "100" on the repetition subtest. On the naming and word finding subtest, a score of "68" out of "100" was achieved. This subtest measures object naming, word fluency, sentence completion, and responsive speech. The WAB-R was not administered at the start of the study; instead the WAB-R results from her clinical records (administered seven months prior to the start of this study) were used as baseline measures. Between the pre-therapy WAB-R administration and the start of this study, the participant attended individual therapy two times per week and group therapy one time per week. Individual therapy focused on improvement of reading and writing skills through phoneme to grapheme training. Group therapy sessions were based on a life participation approach, which emphasized social participation in a group setting.

Inter-rater reliability calculations were completed in order to obtain a level of homogeneity in scoring between multiple scorers. Calculations were completed by comparing scoring of the WAB-R between two speech-language pathologists that are familiar with administering and scoring standardized assessments. All intra-rater and inter-rater reliability scores were above p=.05, which indicate consistent scores were obtained between the researcher and the other scorers.

VAST:

The VAST measures verb and sentence processing and identifies deficits at the sentence level in aphasia. The participant's overall pre-therapy performance on the sentence comprehension portion of the VAST was 67.5% accuracy. The participant had a greater level of accuracy on non-canonical sentences (75%) as compared to canonical sentences (60%). When comparing active sentences and passive sentences, the participant achieved a higher score on passive than active sentences (80% and 50%, respectively). On subject cleft and object cleft sentences, the participant comprehended 70% of sentences on both sentence types. All inter-rater and intra-rater reliability scores were consistent, as indicated in Table 4.

NAVS:

The NAVS is designed to measure syntactic deficits in aphasia through comprehension and production of verbs and sentences. Pre-therapy administration of the NAVS included the Verb naming, Verb Comprehension, and Argument Structure Production subtests. On the Verb Naming subtest, the participant correctly named 27.3% of verbs. Of those verbs, the participant named 20% of one-place, 30% of two-place verbs, and 28.6% of three-place verbs. On the Verb Comprehension subtest, the participant understood 100% of 1-place verbs, 60% of two-place verbs, and 71.4% of three-place verbs with an overall score of 72.7%. The participant produced 6.3% of sentences with all arguments and words on the Argument Structure Production test. No one-place verb sentences were correctly constructed, while the participant constructed 6.7% of two-place verb sentences. Of the three-place verbs, the participant produced 8.3% of sentences accurately. Inter-rater and intra-rater scores were consistent, as indicated in Table 6.

In summary, the participant's performance at the onset of this study suggested relative strengths in auditory comprehension on the WAB-R, and verb comprehension as measured on the NAVS. Areas of difficulty included spontaneous speech, repetition, understanding sentences, verb naming, and argument structure production.

Block 1 Outcomes:

WAB-R:

Changes in WAB-R subtests were measured using a test of two proportions with statistical significance at values of $p \leq .05$. Though scores were not statistically significant, small increases in spontaneous speech, auditory comprehension, and aphasia quotient on the WAB-R were seen post-Block 1. Repetition and naming showed a slight decrease from pre-treatment scores. The participant's aphasia quotient score increased by 0.3 points. Aphasia quotient increases of 5 points or greater are considered statistically significant, according to Katz and Wertz (1997). Hence, the changes in WAB-R were not significant. Inter-rater and intra-rater agreement calculations indicate consistent scoring between the researcher and two scorers, as indicated in Table 2.

VAST:

Results from the Sentence Comprehension subtest of the VAST were analyzed using a test of two proportions with statistical significance at the values of $p \leq .05$. Statistically significant positive changes occurred in the canonical sentence category, while the non-canonical sentence category demonstrated a slight decline. Within the canonical sentence category, active sentences demonstrated a greater change than subject cleft sentences. In the non-canonical category, comprehension of passive sentences significantly declined while object clefts remained the same. The overall score on the VAST slightly increased, though not statistically significant. Inter-rater and intra-rater scores were consistent, as seen in Table 4.

NAVS:

All results from the NAVS were analyzed using a test of two proportions with statistical significance at the values of $p \leq .05$. On the Verb Naming subtest, one-place verbs were found to have a statistically significant gain while two-place and three-place verbs did not significantly change. The overall Verb Naming score demonstrated positive change that was merely outside levels of statistical significance.

Two-place verbs on the Verb Comprehension subtest showed statistically significant improvements ($p < .05$) while one-place and three-place verbs both remained the same post-therapy. The overall Verb Comprehension score also showed statistically significant gains ($p < .05$) during post-therapy.

The Argument Structure Production test had positive, statistically significant changes ($p < .05$) in one-place and two-place verbs, while three-place verbs had a positive but insignificant change. A positive, significant change ($p < .05$) in the overall score of the Argument Structure Production test was measured. Inter-rater and intra-rater reliability scores indicate consistent scoring between the researcher and two scorers on each subtest of the NAVS, as indicated in Table 6.

Block 2 Outcomes

WAB-R:

Following the use of TUF treatment and CIAT, the participant demonstrated a clinically significant change in the aphasia quotient (+5.6). Katz and Wertz (1997) describe aphasia quotient score changes of 5.0 or greater to be clinically significant. Positive changes also occurred in spontaneous speech, repetition, and naming and word finding. A positive change in the <u>Spontaneous Speech</u> subtest was due to a statistically significant ($p < .05$) increase in information content, while the fluency, grammar, and paraphasia scores remained the same. In the naming and word finding section, the participant achieved statistically significant ($p < .05$) positive changes in <u>Sentence Completion</u> and <u>Responsive Speech</u> subtests. The <u>Repetition</u> subtest demonstrated positive changes and the scores were just outside of the levels of statistical significance.

A statistically significant ($p < .05$) decline in auditory verbal comprehension was evident post-therapy. Within the <u>Auditory-Verbal Comprehension</u> subtest, following sequential commands section significantly ($p < .05$) declined, which largely contributed to the overall low score. Slight declines in the sections of comprehension of “yes” and “no” questions and auditory word recognition were present, though not significant. Inter-rater and intra-rater agreement scores were consistent, as detailed in Table 2.

VAST:

The participant’s comprehension of canonical sentences showed a positive and statistically significant change ($p < .05$), while non-canonical sentence comprehension did not significantly change. Within canonical sentence types, subject cleft sentences significantly improved ($p < .05$) while active sentence comprehension did not significantly change. Non-canonical sentence comprehension types (passive and object-cleft sentences) did not significantly change post-therapy. Inter-rater and intra-rater agreement scores were consistent, as shown in Table 4.

NAVS:

On the Verb Naming subtest, significant gains (*p* < .05) were observed on one-place and three-place verbs. Two-place verbs also showed an increase, but it did not reach statistical significance. The participant's overall score on the verb naming subtest showed significant improvements post-therapy. The participant's score on three-place verbs on the Verb Comprehension subtest was found to be significantly better than the baseline scores. Comprehension of one-place and two-place verbs remained the same as pre-therapy levels. The overall score for the Verb Comprehension subtest was positive, but not statistically significant.

Statistically significant improvements on the Argument Structure Production subtest occurred with one-place and two-place verbs (*p*< .05). Three-place verbs demonstrated improvement, though not significant. Inter-rater and intra-rater agreement scores for all subtests of the NAVS were found to be consistent, as depicted in Table 6.

Overall Pre-Post-Treatment Outcomes

WAB-R.

Overall, the participant demonstrated positive increases in Spontaneous Speech, Repetition, and Naming and Word Finding. In Spontaneous Speech, the Information Content score significantly increased while the Fluency, Grammar, and Paraphasia score did not change. Within the Naming and Word Finding section, the participant's score on the Object Naming section increased, though changes were not significant. Responsive Speech remained the same as pre-therapy levels. Change in the participant's aphasia quotient score was clinically significant (+5.9). Significant declines were observed in the Auditory-Verbal Comprehension subtest (*p* < .05). Particularly, the Sequential Commands section significantly declined (*p* < .05).

Performance on Auditory Word Recognition section showed a slight, insignificant decline. In the Naming and Word Finding subtest, the word fluency section significantly declined ($p < .05$).

VAST:

Comprehension of canonical sentence types showed a statistically significant increase while non-canonical sentence types did not significantly change. Within canonical sentences, both active and subject-cleft sentences demonstrated significant gains. Non-canonical sentence comprehension of passive type sentences declined significantly while object-cleft sentences showed a slight, insignificant increase. An insignificant increase in the participant's overall sentence comprehension score was also observed.

NAVS:

On the Verb Naming subtest, significant improvements occurred on one-place, two-place, and three-place verb types ($p < .05$). Furthermore, the participant's overall Verb Naming score demonstrated a statistically significant gain ($p < .05$). The Verb Comprehension subtest, also showed a significant overall gain ($p < .05$). Specifically, two-place and three-place verbs were noted to increase significantly ($p < .05$). Comprehension of 1-place verbs remained stable and did not demonstrate any change.

On the Argument Structure Production Test, significant improvements were noted with one-place, two-place, and three-place verbs ($p < .05$). The overall Argument Structure Production Test score showed a positive and significant gain ($p < .05$).

Maintenance

Maintenance testing was completed three months following the completion of the second block of treatment to determine the nature of therapy effects over a period of time. During post-treatment time, the participant received weekly speech therapy services in a group setting with other PWAs. The participant attended a total of six group therapy sessions over the three-month period. Group therapy centers on improving functional communication in everyday life through conversational strategies and facilitating participants' self-advocacy skills. Conversational strategies include asking and answering questions, advocating for oneself, and extending and maintaining conversation while participating in a group.

The WAB-R was re-administered three months following the end of Block 2. No statistically significant changes were observed on any subtests, including the aphasia quotient. However, a statistically significant ($p < .05$) positive change within the Auditory-Verbal Comprehension subtest occurred on the Sequential Commands section. Within the Naming and Word Finding section, the Responsive Speech section significantly declined ($p < .05$). Inter-rater and intra-rater reliability measures were found to be consistent, as indicated in Table 2.

On the VAST, overall changes in Sentence Comprehension were not significant. However, there was a significant decrease ($p < .05$) in the comprehension of canonical sentences. Within the canonical sentence types, subject-cleft sentences significantly declined ($p < .05$) while the decline in active sentences was not significant. Comprehension of non-canonical sentences showed a slight, insignificant decline. Both types of non-canonical sentences did not show a significant change. Comprehension of passive sentences declined slightly while object cleft sentences remained the same. Inter-rater and intra-rater consistencies for Sentence Comprehension were consistent, as seen in Table 4.

The participant's overall performance on the Verb Naming test of the NAVS demonstrated an insignificant decline. Two-place and three-place verb naming scores decreased insignificantly, while one-place verb naming significantly declined (*p* < .05). On the Verb Comprehension test, no significant changes in overall score and subtests occurred. The overall score of the Argument Structure Production test significantly declined (*p* < .05) with declines seen across all verb types (i.e. 1-place, 2-place, and 3-place verbs). Inter-rater and intra-rater agreement scores for each section of the NAVS were consistent, as indicated in Table 6.

In summary the pre-post assessments across treatment blocks show that:

1. *There was a clinically significant gain in the aphasia quotient of the WAB-R, in Block 2 as compared to Block 1. The participant was able to maintain the gains made 3 months after discharge from individual therapy.*
2. *Both Blocks 1 and 2 results from the VAST Sentence Comprehension test demonstrated statistically significant gains (p < .05) in the overall canonical sentence score. Greater gains in active sentences were observed in Block 1, while subject-cleft sentences had greater increases in Block 2. Significant declines (p < .05) in canonical sentence types, including subject clefts, occurred three months post-treatment. Yet, declines remained above pre-treatment levels.*
3. *Both Blocks 1 and 2 NAVS Verb Naming results showed significant gains (p < .05) in one-place verbs. Significant increases (p < .05) in naming three-place and overall verb naming were seen after Block 2 treatment, indicating greater gains in Block 2. The participant's gains in one-place and overall verb naming significantly declined (p < .05) three months post-treatment, though not to pre-treatment levels.*

4. *Block 1 NAVS* <u>*Verb Comprehension*</u> *scores increased significantly (p < .05) in two-place and overall verb comprehension. Three-place verb comprehension gains were significant (p < .05) after Block 2 treatment. All gains were maintained three months post-treatment.*
5. <u>*Argument Structure Production*</u> *scores of one-place, and two-place verbs, and overall score on NAVS showed significant gains (p < .05) in both blocks. Scores significantly declined (p < .05) three months post-therapy, though not to pre-treatment levels.*
6. *Spelling abilities (control variable) did not show significant changes throughout both blocks of treatment, as measured by the Arizona Battery of Reading and Spelling.*

Outcomes of Therapies

Treatment utilized four lists of ten verbs each, to train the participant to use complete sentences to increase fluency and construction of grammatically correct sentences. The participant's ability to correctly produce complete, active sentences from the lists of action words was collected during baseline, treatment, and post-treatment blocks. List 1 was treated during Block 1, while List 2 was treated during Block 2. Treatment lists were targeted until 80% mastery across three consecutive sessions occurred. After mastery of the treatment list, a new treatment list was to be targeted. The participant did not meet the mastery criteria of 80% accuracy in either block and hence, there was no need for introduction of new treatment lists in both treatment blocks.

Effect size calculations were used as a non-parametric statistic to measure the magnitude of treatment outcomes. Effect size benchmarks were derived from a meta-analysis that examined single-subject effect sizes for syntactic production treatment, as described by Beeson and Robey (2006). In Block 1, the treated list (List 1) showed no significant changes although a small effect size was seen when responses across all lists were calculated, whereas the treated list (List 2) demonstrated a significant effect size during the second block of treatment. Overall pre-post therapy changes in effect sizes were significant for List 1 (medium), List 2 (medium), and the overall list (large).

Table 10

Effect Size Changes

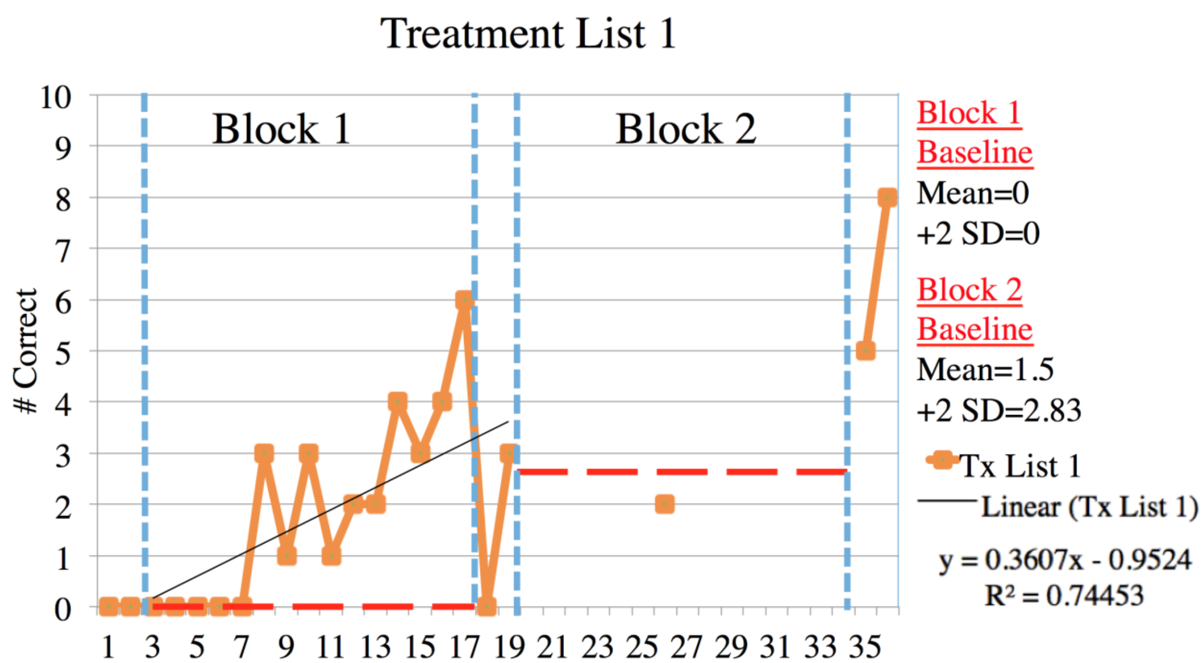
Treatment Stimuli	Pre-/Post Block 1	Pre-/Post Block 2	Pre-/Post Overall
List 1	3.00	3.33	13.00
List 2	2.00	6.00	14.00
Probe List	0	5.00	5.00
Gen. List	2.00	2.00	4.00
Overall	7.00	5.80	36.00

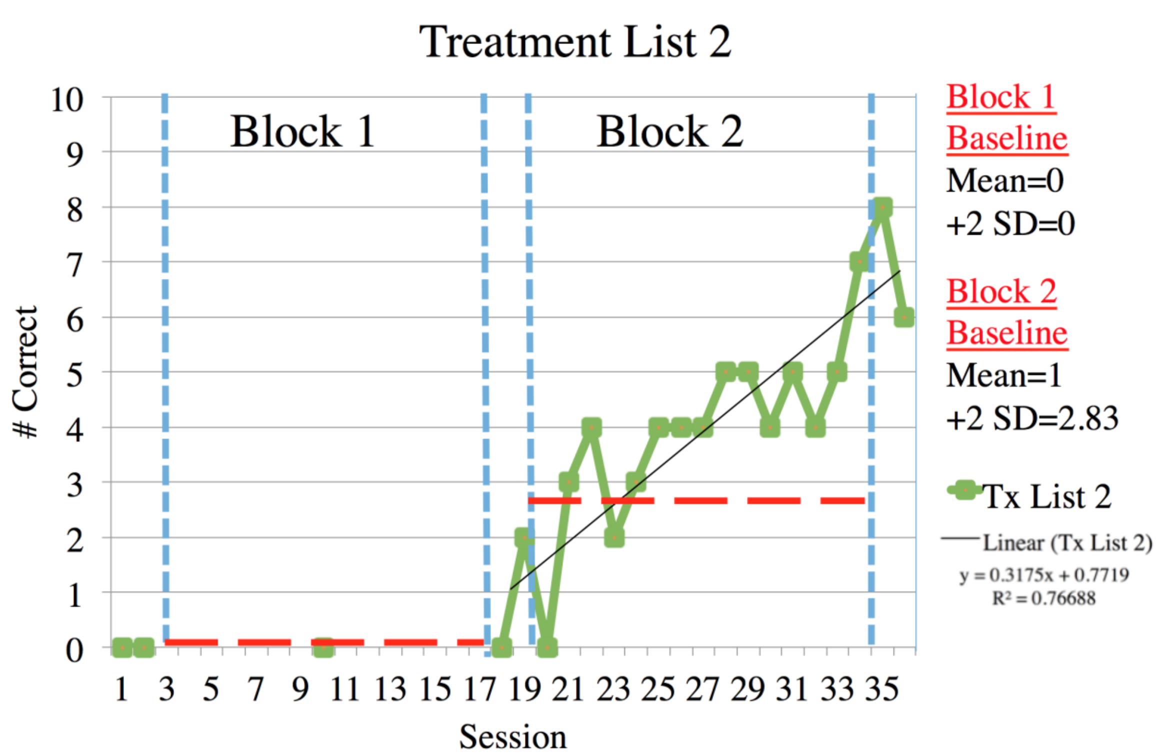
Table 11

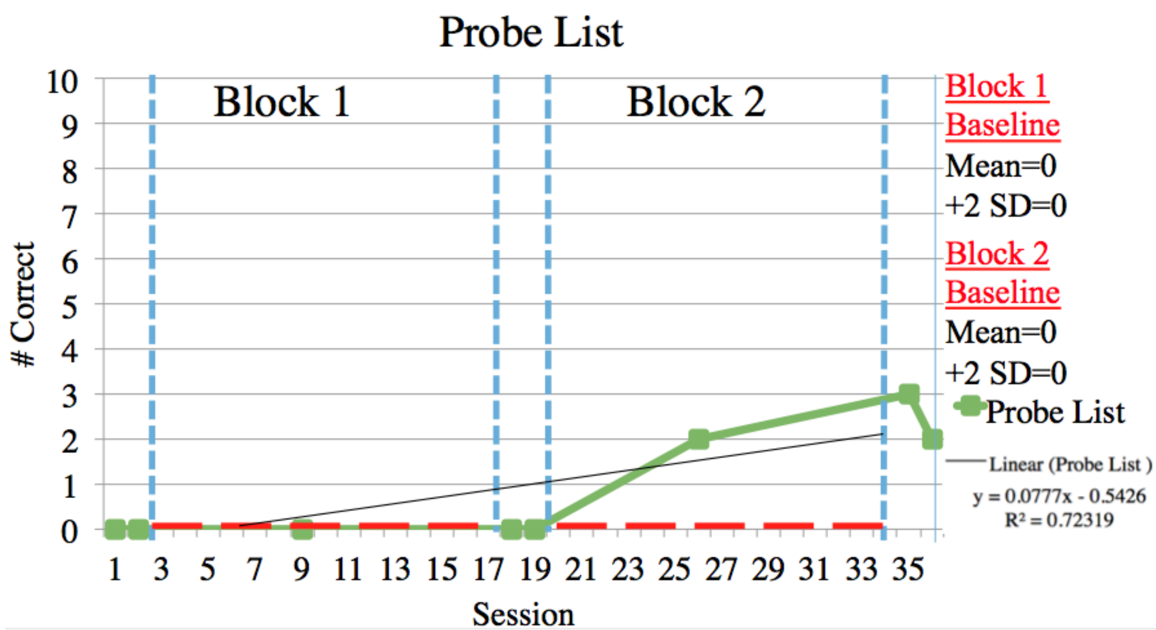
Effect Size Value Benchmarks

Effect Size	Value
Small	6.00-11.99
Medium	12.00-17.99
Large	>18.00

A visual inspection using the two-standard deviation band as described by Nourbakhsh and Ottenbacher (1994) was performed to indicate whether a significant change in performance had occurred across sessions during the treatment blocks. The two-standard deviation band method is ideal for single-subject research designs since it is sensitive to changes in variability across sessions during phases of treatment. If at least two consecutive data points in the treatment phase fall above or below two standard deviations of the baseline mean, then a significant change is considered to have occurred (Nourbakhsh & Ottenbacher, 1994). Figure 1 illustrates the results for each of the treatment and generalization lists individually.


Treatment List 1
Block 1
Block 2
Correct
10
9
8
7
6
5
4
3
2
1
0
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35
Block 1 Baseline
Mean=0
+2 SD=0
Block 2 Baseline
Mean=1.5
+2 SD=2.83
Tx List 1
Linear (Tx List 1)
y = 0.3607x - 0.9524
R² = 0.74453


Treatment List 2
Block 1
Block 2
Correct
10
9
8
7
6
5
4
3
2
1
0
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35
Session
Block 1 Baseline
Mean=0
+2 SD=0
Block 2 Baseline
Mean=1
+2 SD=2.83
Tx List 2
Linear (Tx List 2)
y = 0.3175x + 0.7719
R² = 0.76688



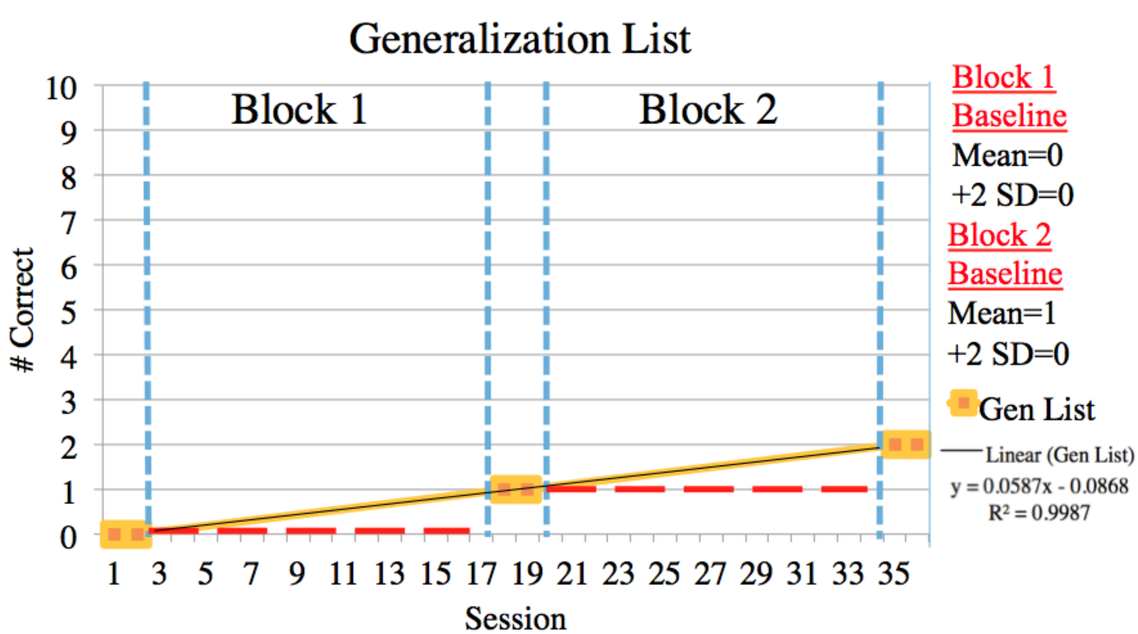


Figure 1. Visual Analysis and Slopes for Each Treatment Block

In List 1, which was treated during Block 1, ten consecutive data points occurred above the two-standard deviation line, indicating significant progress. Linear equations and slope values were calculated to measure rate of change of treatment verbs. List 1 produced a slope value of 0.3607. List 2 results did not demonstrate any significant changes during this Block 1.

In Block 2, significant progress was measured on the treated List 2, since twelve consecutive points fell above the two standard deviation line. List 1 changes were also significant, as two consecutive data points were above the two-standard deviation line. Additionally, List two produced a slope value of .3175.

In Block 1, the Probe List did not satisfy the criterion for statistically significant progress, while the Generalization List did meet the criterion with two data points above the standard deviation line. Block 2 results for both Probe and Generalization Lists satisfied the criterion for significance, with three and two points above the standard deviation line, respectively.

Criterion-Referenced/Functional Outcome Measures

Three discourse samples were collected and analyzed pre-Block 1, post-Block 1/pre-Block 2, and post-Block 2 of treatment. Discourse measures provide a way to examine treatment effects on a PWA's communication skills in unstructured contexts that are similar to situations encountered in everyday life. Discourse samples consisted of a procedural sample (describing how to make a peanut butter jelly sandwich), a picture description sample (from the WAB-R), and a narrative sample (retelling a familiar children's story). Transcription of discourse samples are listed in Appendix F. Discourse samples were recorded, transcribed, and analyzed using the discourse analyses procedures outlined by Nicholas and Brookshire (1993). Based on these guidelines the number of words, words per minute, number of CIUs, and percent CIUs were calculated. Correct information units (CIUs) provide an overall description of informativeness and efficiency of conversational speech. Results and inter-rater and intra-rater reliability scores are presented in Tables 12 and 13.

Table 12

Correct Information Unit Discourse Analysis

Correct Information Units Analysis		Pre-Block 1	Post-Block1/Pre-Block 2	Post-Block 2
Procedural Discourse Sample	# Words	4	**12 (+8)**	13 (+1)
	# of CIUs	1	**5 (+4)**	7 (+2)
	% CIUs	25%	**42% (+17%)**	54% (+12%)
	Words/Minute	1.33	**4 (+2.67)**	4.33 (+.33)
	CIUs/Minute	.33	**1.67 (+1.34)**	2.33 (+.66)
Narrative Discourse Sample	# Words	9	5 (-4)	**15 (+10)**
	# of CIUs	6	3 (-3)	**8 (+5)**
	%CIUs	67%	60% (-7%)	53% (-7%)
	Words/Minute	4.5	1.67 (-2.83)	**5 (+3.33)**
	CIUs/Minute	2	1 (-1)	**2.67 (+1.67)**
Descriptive Discourse Sample: WAB-R	# Words	8	8 (0)	**11 (+3)**
	# CIUs	7	7 (0)	**11 (+4)**
	% CIUs	88%	88% (0)	**100% (+12%)**
	Words/Minute	2.67	2.67 (0)	**3.67 (+1)**
	CIUs/Minute	2.33	2.33 (0)	**3.67 (+1.34)**
*Green highlight indicates positive change *Yellow highlight indicates negative change *Bold text indicates block of treatment with largest gains				

Post-Block 1 Results show that procedural discourse significantly improved, while not other improvements were seen on other discourse types. Following Block 2, gains in all discourse measures were apparent. The greatest gains were measured in narrative and descriptive discourse.

Table 13

Correct Information Unit Reliability Scores

	Researcher – Rater 1	Rater 1 – Rater 2	Researcher – Rater 2
Pre-Block 1			
Procedural	z=0.00, p=1.00	z=0.00, p=1.00	z=-.76, p=.450
Narrative	z=.49, p=.626	z=.49, p-.626	z=0.00, p=1.00
Descriptive	z=0.00, p=1.00	z=0.00, p=1.00	z=0.00, p=1.00
Post-Block 1/Pre-Block 2			
Procedural	z=0.00, p=1.00	z=.42, p=.672	z=.42, p=.672
Narrative	z=0.00, p=1.00	z=0.00, p=1.00	z=0.00, p=1.00
Descriptive	z=0.00, p=1.00	z=0.00, p=1.00	z=0.00, p=1.00
Post-Block 2			
Procedural	z= .39, p=.694	z= .39, p=.694	z=0.00, p=1.00
Narrative	z=0.00, p=1.00	z=0.00, p=1.00	z=0.00, p=1.00
Descriptive	z=0.00, p=1.00	z=0.00, p=1.00	z=0.00, p=1.00

*p-values greater than .05 indicate consistency between ratings

The *American Speech-Language-Hearing Association Quality of Communication Life Scale* (ASHA QCL) was used to measure the participant's perception of quality of life in relation to communication. The ASHA QCL was administered before and after each treatment block. Results and reliability scores are listed in Table 14 and 15.

Table 14

Average ASHA QCL Scores

Administration	Average Score (out of 5)
Pre-/Block 1	3.06
Post-/Block 1	2.82
Post-/Block 2	3.19

Table 15

ASHA QCL Reliability Scores

	Researcher – Rater 1	Rater 1 – Rater 2	Researcher – Rater 2
Pre-Block 1			
ASHA QCL Score	z=0.00, p=1.00	z=0.00, p=1.00	z=0.00, p=1.00
Post-Block 1/Pre-Block 2			
ASHA QCL Score	z=0.00, p=1.00	z=0.00, p=1.00	z=0.00, p=1.00
Post-Block 2			
ASHA QCL Score	z=0.00, p=1.00	z=0.00, p=1.00	z=0.00, p=1.00
Maintenance			
ASHA QCL Score	z=0.00, p=1.00	z=0.00, p=1.00	z=0.00, p=1.00

*p-values greater than .05 indicate consistency between ratings

Results of the ASHA QCL show that the participant's perceptions and feelings about her communication fluctuated throughout the study. However, the participant's score showed an overall change of +.13 upon completion of treatment.

The Arizona Battery for Reading and Spelling (ABRS) (Beeson & Rising, 2010) was used as a control variable in the present study. The ABRS is used to test reading and spelling abilities of regular and irregular spelled words. Results and reliability scores are presented in Tables 16 and 17.

Table 16

ABRS Spelling Test Results

	Pre-/Post Block 1	Pre-/Post Block 2	Pre-Post Therapy (Overall)
Non-word Spelling	0/0 (1.00)	0/0 (1.00)	0/0 (1.00)
Real-word Spelling	1/1 (1.00)	1/0 (.305)	1/0 (.305)

Table 17

ABRS Reliability Scores

	Researcher – Rater 1	Rater 1 – Rater 2	Researcher – Rater 2
Pre-Block 1			
Non-word Spelling	z=0.00, p=1.00	z=0.00, p=1.00	z=0.00, p=1.00
Real-word Spelling	z=0.00, p=1.00	z=0.00, p=1.00	z=0.00, p=1.00
Post-Block 1/Pre-Block 2			
Non-word Spelling	z=0.00, p=1.00	z=0.00, p=1.00	z=0.00, p=1.00
Real-word Spelling	z=0.00, p=1.00	z=0.00, p=1.00	z=0.00, p=1.00
Post-Block 2			
Non-word Spelling	z=0.00, p=1.00	z=0.00, p=1.00	z=0.00, p=1.00
Real-word Spelling	z=0.00, p=1.00	z=0.00, p=1.00	z=0.00, p=1.00

*p-values greater than .05 indicate consistency between ratings

Chapter IV: Discussion

Traditional cognitive-linguistic treatments focus on remediating underlying impairments in PWAs. One cognitive-linguistic treatment method used to remediate sentence level deficits in agrammatic aphasia is the Treatment of Underlying Forms (TUF) (Thompson, 2001). A number of studies have supported the use of TUF to train complex sentences that generalize to simpler sentences (Love, Swinney, Walenski, & Zurif, 2008; Thompson, Shapiro, Tait, Jacobs, & Schneider, 1996; Thompson & Shapiro, 1994; Thompson, Ballard, & Shapiro, 1998; Ballard & Thompson, 1999). TUF and most other therapies are carried out using the auditory-verbal modality without explicitly addressing auditory processing, which is frequently affected in PWAs (Strauss et al., 2003). Currently, there is limited research that investigates the effects of cognitive-linguistic treatment (such as TUF) and auditory process training (such as CIAT) on overall language abilities in PWAs. For this reason, the following study was completed with the objective of determining the differences functional communication outcomes in a PWA under two conditions:

1. Cognitive-linguistic therapy (TUF) in isolation and
2. Cognitive-linguistic therapy (TUF) in combination with auditory process training (CIAT)

> The following null hypothesis was targeted: The use of TUF in combination with CIAT will yield no significant gains in overall language abilities and communication, as compared to TUF treatment used in isolation.

Overall results from this study yielded some positive outcomes for TUF used in combination with CIAT, which lead to the rejection of the null hypothesis described above. A summary of the main results and results of the study are discussed.

Main Results Summary

TUF used in conjunction with CIAT appears to be more effective than TUF alone, as evidenced by standardized and criterion-referenced/functional measures. Following the first block of treatment, no significant gains in overall language ability occurred, as evidenced by the WAB-AQ score. However, increases in sentence comprehension of canonical sentences (including active sentence types), and passive sentences (including non-canonical sentences) were measured. Both canonical and passive sentence types were targeted in TUF, so these changes align with therapy targets. Increases in one-place verb naming abilities were also apparent. One-place verbs were not explicitly targeted throughout therapy (two-place verbs were targeted), so this result suggests that the participant generalized therapy gains to simpler forms of sentences. Furthermore, increases in verb comprehension in two-place and the overall number of verbs named occurred. The participant’s ability to create complete sentences on the Argument Structure Production Test also demonstrates generalization of treatment effects to simpler verb forms. The participant significantly improved on producing sentences with one-place, two-place, and the overall total number of complete sentences.

Positive trends on criterion-referenced/functional measures can also be observed post-Block 1. A small effect size is present on the overall score for the verb lists (40 verbs total), while no other effects on the verb lists reached the criterion for significance. Furthermore, therapy outcomes using the two-standard deviation method show that the participant made significant gains on List 1 (treated list) and the Generalization List. This shows that the participant made gains on the trained verb list and treatment effects also generalized to untrained verbs encountered on the generalization list. Discourse analyses also demonstrated increases in procedural and narrative discourse, while a decline in narrative discourse was obtained. However, the participant's self-perception of her communication quality of life declined minimally from the initial baseline score. Overall, outcomes of TUF used in isolation resulted in positive changes across a variety of measures.

Following the second block of therapy (TUF used with CIAT), enhancements of treatment effects were observed. A significant gain in overall language ability occurred, as measured by the WAB-R AQ score. Examining the subtests more closely, gains on the Sentence Completion and Responsive Speech subtests of the WAB-R are also notable. These tests rely heavily on auditory attention and word finding ability. It has been documented that PWAs perform less accurately on word finding tasks that tax attentional resources (Murray, 2000). It could be hypothesized that these increases are due to addressing the participant's auditory attention abilities through CIAT. Furthermore, significant gains in comprehension of canonical sentences were measured. Since canonical sentence types were targeted during therapy, this effect could be expected. Additionally, verb comprehension of three-place verbs significantly increased post-Block 2. This is notable since three-place verbs were not formally targeted during therapy and is more complex than the targeted, two-place verbs. Furthermore, this trend is observed in verb naming abilities, as the participant significantly increased verb naming of three-place verbs. Three-place verb gains were not noted in the first block of therapy, so it is possible that CIAT facilitates the processing of more complex verbs through TUF. One-place verb naming also showed significant gains, which again show generalization of treatment effects to simpler verb forms, consistent with the CATE effect. The overall verb naming score also increased significantly. The participant's ability to create complete sentences on the Argument Structure Production Test also show significant gains in one-place, two-place, and overall score.

Criterion-referenced/functional outcomes also showed greater gains in the second block. A small effect size for the treated verb list in Block 2 (List 2) was measured. In the first block, there was not a significant effect size calculated for the treated verb list (List 1). This shows that changes in treatment effects occurred at a greater magnitude on treated verbs during the second block of treatment, when CIAT was used along with TUF. A visual inspection of all verb lists also shows a greater degree of change following Block 2 of therapy. All verb lists (List, 1 List 2, Probe, Generalization) showed significant changes, as compared to only two lists showing significant gains following Block 1. Discourse measures also showed gains on all measures, which was not measured following Block 1. Furthermore, the participant's communication quality of life rating was at its highest point throughout the study following Block 2.

The above results are consistent with research on the established outcomes of both TUF and CIAT treatments. According to Thompson (2001), TUF focuses on promoting generalization of verb and sentence comprehension and production across sentence types through training complex sentence forms, while CIAT aims to improve auditory processing by training selective attention skills (Hurley & Davis, 2011).

The participant demonstrated the greatest gains in one-place and two-place verb argument production following training of complex, passive sentence forms with two-place verbs (e.g. "it was the boy who chased the girl") in both blocks of treatment. More complex, three-place verbs did not significantly improve in either block but showed a significant gain after 16 weeks of therapy from the initial pre-Block 1 baselines to post-Block 2 outcomes. This change demonstrates that long-term treatment might help in resulting in more global changes across different types of verbs. The significant changes in production of less-complex sentences (active sentences with one-place and two-place verbs) supports the complexity account of treatment effect (CATE), as described by Thompson, Shapiro, Kiran, & Sobecks (2003). CATE suggests that generalization of sentences is enhanced when treatment targets more complex structures (such as passive sentences), rather than less complex sentence structures (e.g. active sentences). Since complex, treated structures encompass information relevant to simpler forms, training of the complex form will also enhance the less complex form (Thompson et al., 2003). It appears that CIAT did not have a significant effect on argument structure production since gains between Blocks 1 and 2 were similar. However, differences in verb naming between Block 1 and Block 2 exist.

The participant's verb naming of one-place verbs increased during both blocks of treatment, while naming three-place verbs significantly increased in the second block of treatment. It is notable that significant changes in naming three-place verbs occurred even though three-place verbs were not targeted in treatment. Additionally, changes in overall verb naming abilities were greater during Block 2. The gains on naming three-place verbs may have been influenced by CIAT. Three place verbs are known to be more difficult than one and two place verbs (Thompson, Lange, Schneider, & Shapiro, 1997). Since three-place verbs have three arguments, it could be argued that a higher cognitive load is associated with these verbs, as opposed to simpler verbs (Nadeau, Rothi, & Crosson, 2000). For language tasks, no matter how seemingly simple, functional allocation of attentional resources would be required for processing words and their attributes. Increases in syntactic complexity of sentences tax the overall processing resources (Nadeau, Rothi, & Crosson, 2000). Therefore, the CIAT training could have facilitated the better outcomes in Block 2.

Furthermore, existing research suggests that language production in individuals with aphasia is sensitive to variations in attentional demands. The capacity theory of attention predicts that impairment in tasks performed simultaneously is the results of competition for limited-capacity attentional resources (Mackintosh, 1975). Automatic processes require less attentional demands, while controlled processes require more attention. PWAs with aphasia generally lose automaticity of language processing. Thus, increased attentional demands in PWAs may have a negative impact on language production. It has been proposed that individuals with agrammatic speech may prefer to use simple sentences or fragments since they are less demanding on processing resources, as compared to producing grammatically complete or more complex utterances (Murray, Holland, & Beeson, 1998). The observed increase in naming more complex, three-place verbs may be attributed to an increase in possible attentional resources following CIAT.

Additionally, the participant's gains in verb comprehension align with the capacity theory of attention. Following Block 2, the participant demonstrated significant gains in comprehending three-place verbs although no significant gains on comprehension of complex sentence forms were seen. Yet, the participant did demonstrate significant gains in comprehension of simpler sentence forms (canonical sentence groups, including subject cleft sentences), which aligns with TUF's results of generalization of treatment effects to simple sentence forms following treatment of complex forms.

The significant language processing gains made in the realm of syntax and semantics were also evident on other language modality tests such as the WAB-R. Scores from the WAB-R indicate important differences between Blocks 1 and 2. Following Block 1 of treatment, no significant changes were measured, including the aphasia quotient. In fact, the participant showed significant declines in sentence completion and responsive speech. In the second block of treatment, the participant's overall language abilities demonstrated a clinically significant gain by an aphasia quotient increase of 5.6. TUF protocol suggests that PWAs appropriate for TUF have an aphasia quotient of 60 or greater (Thompson, 2001). A significant gain in AQ score may have been absent during the first block of treatment due to the participant's pre-treatment AQ being under 60. Block 2 AQ results suggest that CIAT may have enhanced the participant's overall language abilities, as her AQ increased significantly, despite the baseline measure being under 60. Subtests on the WAB-R demonstrated significant improvements, which factor into the aphasia quotient score. The patient's information content, sentence completion, and responsive speech increased significantly. Repetition abilities also demonstrated large gains with a *p*-value of .075.

Increases in repetition skills align with research outcomes for CIAT along with the capacity theory of attention. By increasing selective attention skills, CIAT may have also facilitated repetition skills. Repetition could become a cognitive task, as one does not need to utilize language processes when repeating stimuli. For example, repetition tasks can bypass the language processing centers that may be affected by brain injury (Nozari, Kittredge, Dell, & Schwartz, 2010) and such patients may be able to repeat well, despite their problems in auditory comprehension. Attention and working memory abilities are critical for accessing and retaining information long enough to repeat stimuli. One could argue that the increase in repetition abilities was due to directly addressing attention deficits and increasing attentional capacity (Mackintosh, 1975) through use of CIAT in Block 2.

The Sentence Completion and Responsive Speech subtests of the WAB-R can also be interpreted with the attentional resource model. Significant gains in these subtests were present following Block 2 of therapy, but not Block 1. Success on these subtests is dependent on word retrieval. Research demonstrates PWAs perform less accurately on word retrieval tasks that tax attentional resources (Murray, 2000). These two subtests rely heavily on auditory attention, as one must receive and interpret information presented in the auditory modality and then produce correct responses. By remediating attention deficits and decreasing resources that must be devoted to attention, it could be hypothesized that the participant's word retrieval would also increase.

Aside from various gains recorded on the WAB-R, significant declines in some subtests were also measured. Despite the increase in AQ, the overall Auditory Verbal Comprehension subtest significantly declined in the second block of treatment. A closer examination of the Auditory Verbal Comprehension subtest showed that the Sequential Commands section demonstrated the greatest decline, which greatly impacted the overall score. It is unclear what may have caused the decline in participant's performance. Participant fatigue is one factor that may have influenced this section of the WAB-R since she had participated in various language assessments prior to this assessment. This is corroborated by the fact that her overall auditory verbal comprehension score bounces back to her baselines during the maintenance testing three months following the Block 2 treatment.

Aside from standardized assessment measures, the differences in the outcomes of TUF, and TUF with CIAT were also evident in the treatment effects seen in criterion-referenced and other functional data. TUF with CIAT once again showed greater gains in treatment as compared to TUF alone. By working on auditory attention with CIAT, it is possible that the participant's syntax processing may have been impacted. The treated list in Block 1 had average post-treatment outcome score of 1.5. Of the verb lists in Block 1, the treated list and other lists of verbs showed no significant changes, although the overall score (all the lists put together) showed a small effect size change. However, the two standard deviation method of visual inspection revealed significant gains in both the treated list (List 1) and the Generalization List. This demonstrates that TUF is an effective treatment and is consistent with previous studies.

In comparison to the Block 1 outcomes, the Block 2 outcomes were more robust. In the second block, the treated list (Treatment List 2) showed significant gains in effect size, unlike in Block 1 treatment (Treatment List 1). List 2 demonstrated a small effect size change at the end of Block 2. Furthermore, the two standard deviation visual inspection revealed that, there were significant improvements across all the four lists (both treated and untreated). For example, In Block 2, the untreated list (List 1, which was trained in Block 1) also showed significant gains. This cross-list generalization was not evident in Block 1, i.e., List 2 did not show any significant gains in Block 1 treatment. This trend shows that effects of TUF treatment were greater in the second block for both treatment lists. Additionally, the participant's baseline scores for Treatment List 1 in block two averaged 1.5 (15%), and at the end of Block 2, it increased to an average of 6.5 (65%). This demonstrates that the participant's syntax processing abilities increased on the previously treated verbs. Moreover, Treatment List 2 demonstrated a higher average post-treatment outcome than Treatment List 1 did in Block 1. The Probe and Generalization lists also met criterion for significance in Block 2. Since exposure to the Probe List was limited throughout the study, generalization of syntactic processing changes can be observed in Probe List outcomes. These results indicate that CIAT must have had a large impact on increasing sentence-level processing on trained and untrained verbs. Particularly, CIAT appears to enhance the generalization in TUF treatment. The overall benefits of using CIAT with TUF is in line with the previous results of Rangamani and Roegner (2016), who found that CIAT improved the language outcomes when combined with cognitive-linguistic treatment. This is also evident in the discourse analyses discussed below.

Results from analyses of the participant's discourse align with previous studies (Ballard & Thompson, 1999; Jacobs, 2001) in that pre-treatment to post-treatment discourse samples showed increases in informativeness and efficiency. Furthermore, the participant's POA subjectively reported that the participant's overall communication had shown great improvement since the start of the study. This observation correlates with Ballard and Thompson's (1999) social validity observations of PWAs following treatment using TUF. Non-familiar listeners rated pre-and post-treatment narrative samples on the variables of content, coherence, sentences length, complexity, and grammaticality. Listeners reported that positive changes in narrative discourse in three out of the five PWAs had occurred from pre- to post-treatment.

A comparison of Block 1 to Block 2 discourse outcomes show that while TUF is effective in generalizing to social communication, CIAT appears to enhance these results. Block 1 discourse outcomes on the procedural discourse sample were consistent with the findings of Ballard and Thompson (1999), as the participant's informativeness (as measured using CIUs) and efficiency showed positive changes. However, the narrative discourse sample outcomes showed a decrease in both informativeness and efficiency, while the descriptive discourse sample did not demonstrate any changes. Whereas in Block 2, the participant showed gains across all the different types of discourse genres. For example, in Block 2 of treatment, the participant showed positive gains in procedural discourse, though less than in Block 1. Yet Narrative and Descriptive discourse measures showed an overall positive change. Most notably, the participant's informativeness showed the greatest increase, as her percentage of CIUs increased from 88% to 100%. Thus findings from discourse samples demonstrate that CIAT appears to enhance the generalization of TUF to various discourse genres.

The effects of CIAT are also evident in the participant's QOL measures. The ASHA QCL provided an assessment of the participant's communication quality of life throughout the study. A greater score on the ASHA QCL indicates a greater perception of quality of life in relation to communication. Following the first block of treatment, the participant's score decreased by .24, while in the second block of treatment, scores increased by .37 points. This suggests that the participant perceived herself as having a higher level of quality of communication life following Block 2. Aside from the participant's self-perception of improved communication, family also reported improvements in communication. According to the anecdotal reports of the participant's POA, the participant had gained more confidence in her communication abilities following the second block of treatment. It was reported that the participant engaged in more online phone calls with family and was able to relay her messages more efficiently than previously. Furthermore, increases in the participant's conversation content and fluency were also noted by a steady increase on the spontaneous speech subtest of the WAB-R. Though it didn't reach statistical significance in either block, this positive change correlates with observations made by the participant's POA. Furthermore, increases in the participant's discourse using Nicholas and Brookshire's (1993) analyses align with the findings discussed above. Progressively positive changes in words per minute and CIUs per minute indicate that the participant's content and fluency had increased from previous levels. These findings suggest that CIAT enhances language-processing effects of TUF on both standardized and criterion-referenced measures.

Three months post-therapy maintenance outcomes were obtained to determine whether maintenance of treatment gains were present. The participant maintained treatment gains in overall language ability, as evidenced by a WAB-R AQ score that had not significantly changed. Significant decreases in sentence comprehension were measured on canonical sentences (including subject cleft sentences), while all other sentence types remained stable. On the Verb Naming subtest of the NAVS, significant decline in 1-place verbs was noted, while 2-place, 3-place, and the overall score remained relatively stable. Verb comprehension was reassessed on the NAVS Verb Comprehension test and showed comprehension of verbs was also relatively stable and demonstrated little change. This demonstrates that treatment effects were retained over time.

Most notably, argument structure production had the largest decline three months post-treatment. All verb types (one-place, two-place, and three-place) significantly declined. Two-place verbs declined from a score of thirteen to a score of three. Furthermore, the overall score significantly declined from a score of twenty to a score of five. This suggests that treatment effects were not maintained over a period of time. The lack of maintenance of treatment outcomes may have occurred for a variety of reasons. The duration of treatment periods may have impacted the maintenance outcomes. Research conducted by Bhogal, Teasell, and Speechley (2003) suggests that the total length of therapy is inversely correlated with positive gains in aphasia recovery. The participant's decrease in amount and intensity of therapy following Block 2 may also have impacted maintenance. The participant attended group therapy one time per week, for six sessions before being reassessed three months post-Block 2. Group therapy implements the life participation approach, which centers on social aspects of communication, as opposed to linguistic processing deficits. Since the participant did not have individual therapy that focuses on remediation of linguistic deficits, decreases in language abilities may have occurred.

Conclusions, Limitations and Future Recommendations

This single case study examined the effects of explicit auditory training on the outcomes of traditional cognitive-linguistic therapy. TUF used in conjunction with CIAT enhanced the outcomes of TUF, as compared to TUF alone. This is observed on a variety of measures, including the participant's overall language ability, as measured on the WAB-R AQ.

This study's results also demonstrated that TUF used in isolation is beneficial for increasing linguistic processing of verbs and sentences. Increases in sentence comprehension and production and verb comprehension and production were present following TUF. Furthermore, linguistic processing abilities in certain areas (e.g. complex sentence forms, generalization to untrained stimuli) appeared to accelerate when coupled with the explicit auditory process training through CIAT. These positive effects were present on both standardized and criterion-referenced measures. Thus, it appears that CIAT may have an impact on accelerating overall language gains of TUF and expands evidence of the role of explicit auditory training in a person with moderate, agrammatic aphasia.

Given the limitations discussed below, further research is warranted in order to establish a better understanding of the impact that explicit auditory training has when paired with traditional cognitive-linguistic therapy. Some factors that limit the generalization ability of the findings include a) the single subject design; and b) influence of certain extraneous variables pertaining to the methodology. Administration of the WAB-R directly before the start of the first treatment block could have yielded more accurate pre-therapy language abilities. Additionally, controlling for participant fatigue during testing sessions may yield alternate results.

Thus, treatments with longer treatment periods and reverse order treatment designs are warranted. This may provide further evidence of the impact that CIAT has on traditional cognitive-linguistic therapy. Also, studies with a larger sample size of PWAs with agrammatic aphasia may yield more generalizable results. This may also provide further evidence of changes in language processing that occur when explicit auditory training is provided.

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Appendix A: IRB Approval

Institutional Review Board (IRB)

Office of Research and Sponsored Programs
St. Cloud State University.

Administrative Services 210
Website: stcloudstate.edu/osp *Email: osp@stcloudstate.edu*
Phone: 320-308-4932

Name: Jane Anderson

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Dassel, MN 55325 USA

Email: jeanderson@stcloudstate.edu

IRB PROTOCOL DETERMINATION:
Expedited Review-2

Project Title: Treatment of Underlying Forms and Contraint Induced Auditory Training in Aphasia: A Single Case Study

Advisor Grama Rangamani

The Institutional Review Board has reviewed your protocol to conduct research involving human subjects. Your project has been: **APPROVED**

Please note the following important information concerning IRB projects:
- The principal investigator assumes the responsibilities for the protection of participants in this project. Any adverse events must be reported to the IRB as soon as possible (ex. research related injuries, harmful outcomes, significant withdrawal of subject population, etc.).

- For expedited or full board review, the principal investigator must submit a Continuing Review/Final Report form in advance of the expiration date indicated on this letter to report conclusion of the research or request an extension.

-Exempt review only requires the submission of a Continuring Review/Final Report form in advance of the expiration date indicated in this letter if an extension of time is needed.

- Approved consent forms display the official IRB stamp which documents approval and expiration dates. If a renewal is requested and approved, new consent forms will be officially stamped and reflect the new approval and expiration dates.

- The principal investigator must seek approval for any changes to the study (ex. research design, consent process, survey/interview instruments, funding source, etc.). The IRB reserves the right to review the research at any time.

Good luck on your research. If we can be of further assistance, please contact the Office of Research and Sponsored Programs at 320-308-4932 or email lidonnay@stcloudstate.edu. Use the SCSU IRB number listed on any forms submitted which relate to this project, or on any correspondence with the IRB.

Institutional Review Board:

Linda Donnay
IRB Administrator
Office of Research and Sponsored Programs

St. Cloud State University:

Marilyn Hart
Interim Associate Provost for Research
Dean of Graduate Studies

OFFICE USE ONLY

SCSU IRB# 1532 - 1907	**Type:** Expedited Review-2	**Today's Date:** 1/12/2016
1st Year Approval Date: 1/11/2016	**2nd Year Approval Date:**	**3rd Year Approval Date:**
1st Year Expiration Date: 1/10/2017	**2nd Year Expiration Date:**	**3rd Year Expiration Date:**

Appendix B: Informed Consent

Language Therapy and Auditory Training
INFORMED CONSENT

You are invited to participate in a study about sentence comprehension and production in a person with aphasia who receives language therapy with and without auditory

Contact Information
If you have any questions about this study now or later, please ask. You may contact Jane Anderson at jeanderson@stcloudstate.edu or Dr. Rangamani at 320-308-5769 or gnrangamani@stcloudstate.edu. You will have a copy of this form for your records.

Participation/Withdrawal
Participation is voluntary. Your relationship with SCSU, the researcher, or the SCSU Speech-Language and Hearing Clinic will not change if you do or do not choose to participate. If you participate in this study, you may quit at any time without penalty.

Acceptance to Participate
Your signature indicates that you have read and agree to the information above. You may quit this study at any time, even after signing this form.

____
Signature

____
Date

Appendix C: CIAT Three Syllable Sentences

Form A		
	Left Ear Channel 1	**Right Ear Channel 2**
1	The glass broke	Cows eat grass
2	Tacks are sharp	The cat slept
3	The plant bloomed	Pears are fruits
4	The sun set	Ice is cold
5	He jumped high	The rain stopped
6	We ran far	The woman swam
7	The phone rang	She types fast
8	My leg hurts	The snow fell
9	Mice like cheese	The dog slept
10	The man worked	He ate dinner
11	The frog hopped	It is cold
12	The ship sank	Green means go
13	The wolf howled	They jumped rope
14	We ran fast	The ball bounced
15	The girl cried	Snow is white
16	Fire is hot	The tree fell
17	The grass grew	Most dogs bark
18	She ate lunch	The car stopped
19	The kite flew	The band played
20	The bell rang	Snakes scare me
21	Grass is green	The fire burned
22	He stood up	It is hot
23	The man ran	We stayed here
24	I like cake	He sat down
25	She walked home	The wind blew

Form B		
	Left Ear Channel 1	**Right Ear Channel 2**
1	The bird flew	The team won
2	He is tall	We stayed home
3	She’s happy	The fish swam
4	The team won	Let’s go now
5	John went home	Please call home
6	Who is there?	What’s your name?
7	Did you go?	I am glad
8	Can I go?	We are here
9	Will you stay?	John is sad
10	What is that?	Where is it?
11	Where’s my shoe?	The cow mooed
12	She is tired	Let’s eat now

Appendix D: Verb Lists and Verb Picture Samples

Verb Lists

List 1 (Treatment List)	
	Verb
1	Comb
2	Draw
3	Pass
4	Follow
5	Greet
6	Scratch
7	Push
8	Propose
9	Scold
10	Measure

List 2 (Treatment List)	
	Verb
1	Slap
2	Eat
3	Beg
4	Bow
5	Wink
6	Choke
7	Attack
8	Massage
9	Salute
10	Arrest

List 3 (Probe List)	
	Verb
1	Smell
2	Call
3	Hold
4	Hug
5	Lick
6	Bury
7	Treat
8	Lift
9	Spray
10	Punch

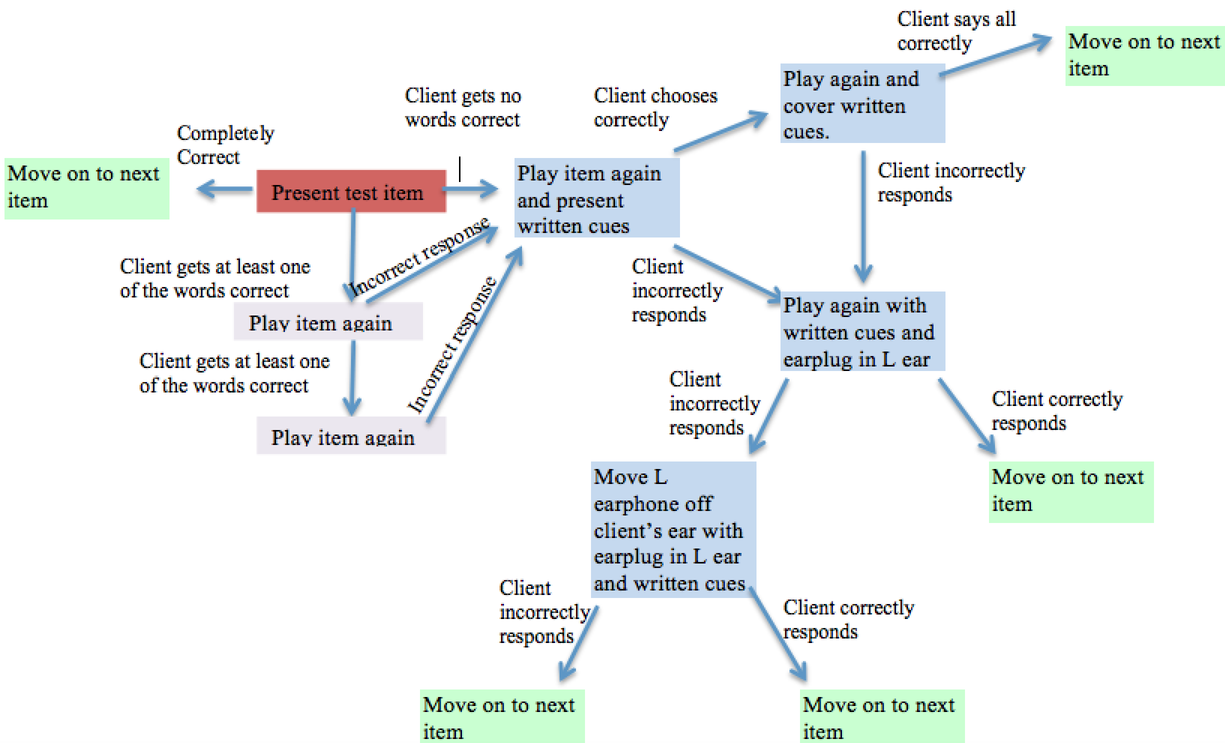
List 4 (Generalization List)	
	Verb
1	Pay
2	Teach
3	Trip
4	Photograph
5	Wipe
6	Weigh
7	Dress
8	Poke
9	Splash
10	Feed

Verb Picture Samples

Retrieved from http://media.gettyimages.com/photos/brown-and-white-dog-licking-tabby-cat-picture-id200396789-001?s=170667a

Retrieved from http://www.gettyimages.com/detail/video/medium-shot-son-showing-mother-scrape-under-bandage-in-stock-footage/1042-17

Appendix E: CIAT Cueing Hierarchy



Appendix F: Discourse Transcripts

Pre-Block 1

Procedural: Peanut butter jelly. Two. Peanut butter, (unintelligible word).

Narrative: And two of them and three of them

Descriptive: Car, shoes, book, (unintelligible word), sandbox, howling, radio, trees, trees.

Post-Block 1/Pre-Block 2

Procedural: Peanut butter and jelly sandwich, peanut butter, peanut butter sandwich, peanut butter

Narrative: Three pigs, pigs, three little pigs, three little pigs, three little pigs, three little pigs

Descriptive: Trees, car, book, sandals, high, kite, dog, dog

Post-Block 2

Procedural: Peanut butter jelly sandwich, butter, peanut butter sandwich, bread spread, peanut butter bread

Narrative: Three little pigs, one and two of them and three of them, straw, bricks, sticks

Descriptive: Car, sandals, book, pouring glasses, flag, flying kite, dog, sailboat, radio