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I, Julie Griffith , hereby submit this original work as part of the requirements for the degree of Doctor of Philosophy in Communication Sciences and Disorders.

It is entitled:

Post-Stroke Language Remediation Through Constraint-Induced Aphasia Therapy

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Post-Stroke Language Remediation through Constraint-Induced Aphasia Therapy

A dissertation submitted to the

Graduate School

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in partial fulfillment of the

requirements for the degree of

Doctor of Philosophy

in the Department of Communication Sciences and Disorders

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by

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Master of Arts University of Cincinnati

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Abstract

Purpose: The goal of this dissertation was to investigate the effect of constraint-induced aphasia therapy (CIAT) on post-stroke language remediation. Two studies were implemented for this purpose. Study 1: *CIAT: Examining Linguistic Gains in Discourse,* investigated the effects of a 10-day CIAT program on the content, complexity, efficiency, and communicative success of the utterances produced by people with aphasia. Study 2: *CIAT: What About Shaping?,* documented the types of cues provided by clinicians during a CIAT program and examined the cues given for changes in number, type, and power across the program.

Method: The studies were performed as part of a larger randomized controlled trial (NCT00843427) with in the National Institute of Health project (NIH R01 NS048281), "*fMRI of Language Recovery Following Stroke in Adults"* PI: Jerzy P. Szaflarski, M.D., Ph.D. The larger investigation utilized a prospective design which consecutively enrolled nine people with aphasia whose discourse was analyzed with a repeated measures design in Study 1. The measures examined were: percent of (a) correct information units (CIUs), (b) counted words, (c) mazes, (d) true conversational units (TCunits), (e) initial successful turns as well as (f) type token ratio (TTR), (g) mean length of utterance (MLU), and (h) CIUs per utterance. The focus of Study 2 was the cueing behavior of seven clinicians trained to facilitate the treatment. The cues provided were categorized into 11 types and were assigned a level of power. The cue types included: (1) request attention, (2) reminder, (3) constraint, (4) semantic function, (5) semantic phrase completion, (6) semantic reminder, (7) phonetic cue with visual model, (8) phonetic cue first phoneme(s), (9) articulatory placement, (10) choice of two words, and (11) word imitation. Both investigations employed non-parametric statistics to detect significant differences in the dependent measures.

Results: The analyses utilized in Study 1 revealed that the people with aphasia exhibited positive significant gains in the percent of CIUs, counted words, TCunits, mazes and CIUs per utterance produced. However, a significant decrease in TTR was revealed. The participants displayed a trend for increased MLU, but no significant increases were detected. No changes were detected in the initial successful requests of the people with aphasia. In Study 2, the analyses showed no significant differences in the number, type, and power of cues provided by the clinicians. Although, inspection of the raw data revealed that more cues were given at the end of the program than the beginning and no discernable pattern of change in the type and power of cues provided could be determined.

Conclusion: Through this dissertation, post-stroke language remediation was advanced by: (1) identifying discourse measures that detect improvements in the verbal language produced by individuals during CIAT, and (2) broadening the definition of shaping to include the specific cues clinicians give to improve the verbal abilities of people with aphasia. This dissertation presents an emerging conceptualization of CIAT that may enhance future protocols by investigating the role of shaping and promoting skills necessary for people with aphasia to become independent communicators through post-stroke communication rehabilitation.

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This dissertation is dedicated to the men and women living with aphasia who daily display courage, perseverance and hope; they are truly inspiring. They have motivated me to be a better clinician, researcher, teacher and most importantly to never give up or stop striving to reach my full potential.

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My sincerest thanks goes to Dr. Jerzy Szaflarski, whose support, vision and compassion for people with aphasia made this project possible under, "*fMRI of Language Recovery Following Stroke in Adults"* (NIH R01 NS048281).

Ten years ago I said "I do" to the love of my life. Marc has supported me unconditionally every step of this long journey and never stopped encouraging me to chase my dream. I only hope that I can return the love and support that he has given me throughout my tenure at the University of Cincinnati.

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CHAPTER 1

Background & Motivation

Aphasia is defined as "an acquired communication disorder caused by brain damage, characterized by an impairment of the four language modalities: speaking, listening, reading, and writing" (Hallowell & Chapey, 2008, p.3). The essence of the communication disorder can be described as knowing what one wants to say but being unable to say it (Kurland, Pulvermuller, Silva, Burke, & Andrianopoulos, 2012). One individual described their aphasia in this way, "I couldn't enter the conversation. Powerless…My tongue was fine but I couldn't come up with the right words or put them in the right order" (LaPointe, 2011, p. 9). Cerebrovascular stroke is the leading cause of acquired communication disorders in adults (Meinzer et al., 2004). There are nearly 800,000 new strokes each year (Go et al., 2013) and approximately 20 - 40% of stroke survivors experience aphasia (National Aphasia Association, 2014). Therefore, nearly 250,000 Americans will acquire aphasia this year (National Aphasia Association, 2014); of which approximately 50 - 60% will experience the disorder chronically (Maher et al., 2006).

Many people with aphasia have difficulty reintegrating into society and maintaining their previously established social roles because of their acquired language deficits (Dietz, Thiessen, Griffith, Peterson, & Sawyer, 2013; Pulvermuller & Bethier, 2008; Vickers, 2010). Even more, employment opportunities and a previous standard of quality of life often elude people with aphasia (Parr, 2007; Worrall et al., 2011). In response, the field of aphasiology has established many restorative therapeutic language interventions. Constraint-induced aphasia therapy (CIAT) is one restorative therapeutic program designed to remediate the linguistic deficits associated with aphasia.

Constraint-Induced Aphasia Therapy

Constraint-induced aphasia therapy has been implemented over the past 15 years under the names “constraint-induced language therapy” (CILT) (Maher et al., 2006, p. 843; Breier, Maher, Novak, & Papamicolaou, 2006, p. 322), “intensive language-action therapy” (ILAT) (Difrancesco, Pulvermuller, & Mohr, 2012, p. 1317), and “constraint-induced aphasia therapy” (CIAT) (e.g., Pulvermuller et al., 2001, p. 1622; Meinzer, Djundja, Barthel, Elbert, & Rockstroh, 2005, p. 1462; Szaflarski et al., 2008, p. 243; Kurland et al., 2012, p. 65). For the purposes of this dissertation, the term CIAT will be employed. Constraint-induced aphasia therapy was developed as an intensive restorative treatment for the amelioration of spoken expression and based on principles adapted from neuroscience and constraint-induced movement therapy (CIMT) (e.g., Breier et al., 2006; Kurland et al., 2012; Meinzer, Rodriguez, & Gonzalez-Rothi, 2012; Pulvermuller et al., 2001). In particular, the goal of CIAT is to overcome learned non-use behavior and was founded on the principles of Hebbian learning, intensity, constraint of nonverbal communication, and language shaping. Each of these founding ideologies is discussed in the following sections.

Learned motor non-use. The concept of learned motor non-use is prevalent in physical rehabilitation for hemiparetic limbs (Taub, Uswatte, Mark, & Morris, 2006). Learned motor non-use was first observed in basic research conducted with monkeys who underwent surgical deafferentiation of a limb (Taub, Barro, Parker, & Gorska, 1972; Taub, 1980; 1977). The core of learned motor non-use is that while motor deficits resulting from damage to the central nervous system (CNS) exist, the damage is not solely responsible for all the observed deficiencies in motor movement. Rather, the observed lack of motor movement can also be explained by a learned and rewarded suppression of movement—coined “learned non-use” (Taub et al., pp.

242). For example, when a monkey attempts to use an impaired limb it may receive negative reinforcement by climbing and obtaining food inefficiently and so is motivated not to use the affected limb in order to find food and shelter more proficiently. The learned motor non-use theory has been successfully translated to human stroke rehabilitation for individuals who experience post-stroke hemiparesis (e.g., Gotta et al., 2004). However, many stroke survivors also experience the learned non-use phenomenon for spoken language.

Learned non-use of spoken communication. Since damage to the CNS not only brings about motor impairments but language impairments as well, it stands to reason that if people demonstrate learned motor non-use, then they also would exhibit learned non-use of spoken communication. Therefore, researchers began to apply the theory of learned non-use to spoken communication (Ball et al., 2006b; Meinzer, Elbert, Djundja, Taub, & Rockstroh, 2007a, Pulvermuller et al., 2001; Szaflarski et al., 2008). The negative reinforcement that people with aphasia receive from communication partners after unsuccessful spoken communication reduces their motivation to speak, so they may tend to avoid talking altogether. In the view of people with aphasia, it may be easier to avoid spoken communication than suffer the negative consequences of communicative breakdowns. Figure 1 depicts the development of learned non-use of spoken communication (adapted from Ball et al., 2006a; Taub et al., 2006). Learned non-use of spoken communication begins with damage to the CNS, which causes decreased language function, or aphasia. In turn, these deficits result in unsuccessful communication, which is negatively reinforced by an individual's

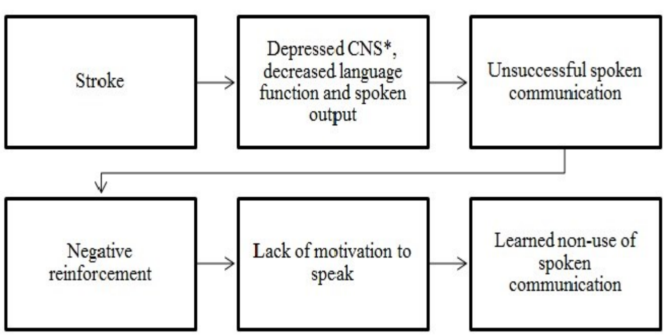

Figure 1. Development of learned non-use of spoken communication adapted from Ball et al. (2006) and Taub et al. (2006). * CNS: central nervous system.

environment. Negative reinforcement of spoken communication then leads to decreased motivation and avoidance of situations where verbal output is necessary (Godecke, Armstrong, Hersh, & Bernhardt, 2013; Taub et al., 2006). Thus, the behavior of learned non-use of spoken communication is established and perpetuated. A recent investigation observed that people with aphasia in the acute phase of their recovery spent significantly less time engaged in communicative interactions than people without aphasia who survived similar strokes (Godecke et al., 2013). This evidence suggests that the decrease in social interactions experienced by people with aphasia early in their stroke recovery instigates “learned communicative non-use” (Godecke et al., 2013, p.3) behavior.

Constraint-induced interventions. Investigations of CIMT revealed that when monkeys had their unaffected limb constrained, they were highly motivated to use their deafferented limb to receive positive reinforcements, such as food. The monkeys eventually overcame any learned motor non-use behavior by being motivated to use their impaired extremity. Follow up studies with the monkeys documented the animals’ motor recovery; the findings suggest that increased intensity generates greater generalization and maintenance of improvement (Taub et al., 1972; Taub & Heitmann, 1977; Taub, Uswatte, & Pidikiti, 1999). In fact, Taub et al. (2006) later stated that, when the constraint treatment was implemented with human stroke survivors, “…learned non-use of an affected extremity can be overcome by the application of an efficacious treatment, such as constraint-induced (motor) therapy” (p. 245). In stroke recovery, CIMT reduces the effects of hemiparesis (e.g., Gotta et al., 2004; Liepert et al., 2000). Therefore it stands to reason that the application of constraint-induced language treatment (i.e., CIAT) could also alleviate the effects of post-stroke aphasia. Pulvermuller et al. (2001) was the first to document the application of CIAT with the intention of overcoming learned non-use of spoken communication through the adoption of principles from CIMT: a) intensity, b) constraints, and c) language shaping.

Intensity. The first principle of CIAT, intensity, is achieved by treatment programs that require concentrated practice (e.g., three-to-four hour-long treatment sessions, five days a week, for two weeks) (e.g., Difrancesco et al., 2012; Kirmess & Lind, 2011; Maher et al., 2006; Meinzer et al., 2012; 2005; Pulvermuller et al., 2001). Intensity has been shown to be a crucial element in the effectiveness of aphasia therapies. Bhogal and colleagues completed a meta-analysis investigating the range of intensity offered by aphasia interventions and revealed that more intensive therapeutic protocols generate greater linguistic outcomes for people with aphasia (Bhogal, Teasell, & Speechley, 2003). Specifically, treatment programs that provide daily treatment sessions of two-to-four hours facilitate improved spoken communicative ability (Basso, 2005). Additionally, Cherney et al. (2008; 2010) performed two evidenced-based systematic reviews that specifically examined the available data on the amount of intensity offered by CIAT programs and concluded that intensive CIAT treatment protocols are associated more favorably with positive changes on language impairment outcome measures than less intensive treatment protocols (Cherney, Patterson, Raymer, Frymark, & Schooling, 2008; 2010). Barthel and colleagues (2008) assessed the impact of two intensive aphasia therapies, CIAT and model-oriented aphasia therapy on language outcomes. Model-oriented aphasia therapy is an individual treatment that combines linguistic and communicative strategies to improve expressive language and specifically aims to reduce phonological errors, increase subject-verb congruency, and increase functional communication through paraphrasing and role-playing techniques. The researchers found that the people with aphasia who received model-oriented aphasia therapy and the people with aphasia who received CIAT with the same amount of intensity demonstrated comparable language improvements on portions of a standardized language evaluation. As a result, the researchers concluded that intensive training is an effective element of aphasia rehabilitation (Barthel, Meinzer, Djundja, & Rockstroh, 2008).

The incorporation of intensity into aphasia rehabilitation programs is founded on the well-established neuroscientific idea of synaptic plasticity known as Hebbian learning. Hebb (1949) proposed that learning occurs in two manners, through coincidence and correlation. The first type of learning, coincidence, arises when neurons are activated repeatedly and intensively at the same time, which allows the connections between them to become stronger. Hebb (1949) stated, "…any two cells or systems of cells that are repeatedly [intensely] active at the same time will tend to become 'associated', so that activity in one facilitates activity in the other…" (p. 70). The second manner of Hebbian learning, correlation, is summarized colloquially as "…neurons that fire out of sync lose their link…" (adapted from Hebb, 1949) and explains how neurons become weakly associated and even lose connections when neurons are stimulated independently of each other or infrequently (Artola & Singer, 1993; Pulvermuller & Berthier, 2008). These two methods of Hebbian learning suggest that strong, repeated neuronal associations are necessary for learning. Therefore, ideally, post-stroke aphasia therapy should be provided in an intensive manner to facilitate the neuronal connections required for language recovery. Constraint-induced aphasia therapy adheres to Hebbian learning by calling for concentrated practice of language skills (e.g., Breier et al., 2006; Meinzer et al., 2012; 2004) in order to exploit neuronal strengthening, plasticity, and recovery.

Constraints. During CIMT, stroke survivors are instructed to wear a safety mitt on their less-impaired upper extremity to restrain the use of their intact limb and encourage use of their affected limb (Gotta et al., 2004; Wolf et al., 2006). Since there are no "linguistic mitts" available to use during CIAT, communicative constraints cannot be applied in the same manner as the constraints employed during CIMT (Taub et al., 1999). Instead, people with aphasia are instructed and encouraged to communicate only using spoken language. Alternative forms of communication, including writing, drawing, gesturing, and other forms of augmentative and alternative communication as a substitution for spoken utterances are restricted from use (Difrancesco et al., 2012; Meinzer et al., 2012; Pulvermuller et al., 2001, Szaflarski et al., 2008). For example, if a person with aphasia requests and object by pointing or drawing, they are instructed to verbally request the object and only use pointing and/or drawing to facilitate verbal requests when needed. Maher and colleagues (2006) compared a group of people with aphasia who received CIAT treatment to another group who received *Promoting Aphasics' Communicative Effectiveness* (PACE) (Davis & Wilcox, 1981), a treatment that encourages multiple forms of communication. The results revealed that each of the nine participants demonstrated gains on linguistic outcomes, but the people with aphasia who received CIAT experienced greater linguistic gains than those who received PACE. The researchers theorized that the people with aphasia exhibited greater gains in their spoken discourse following CIAT as a direct result of constraining non-verbal communication to enhance the spoken modality, thus reducing the behavior of learned non-use of spoken communication (Maher et al., 2006). However, Attard and colleagues (2013) came to the opposite conclusion following their comparison of a CIAT-plus (i.e., inclusion of written word stimuli and a home practice program) and a multi-modality therapy approach for anomia. Their goal was to determine whether constraining communication to the spoken modality is essential to improve linguistic output. Based on their findings, the authors suggest that "constraint is unlikely to be crucial for effective anomia therapy in chronic aphasia" (Attard, Rose, & Lanyon, 2013, p. 103). This hypothesis must be interpreted with caution because Attard et al. (2013) based their conclusion on only two individuals with aphasia, who displayed more enhanced noun retrieval after a multi-modality aphasia treatment than after CIAT-plus. Robust evidence from CIMT and CIAT literature indicates that constraint-induced treatments are efficacious (Cherney et al., 2008; 2010; Meinzer et al., 2012) and that the principle of constraint maybe a key element to the treatment as it is employs use dependent and Hebbian learning.

Constraining non-verbal modalities of communication to encourage the use of spoken language may have a positive influence on the outcomes people with aphasia exhibit through the implementation of principles from the use dependent learning theory. This theory is frequently summarized as “use it or lose it” (Kleim & Jones, 2008, p. 227). The use-dependent learning theory is an extension of Hebbian learning as functional recovery of linguistic skills is thought to be dependent upon the use and recruitment of neurons from residual brain areas (Kleim & Jones, 2008). The creation of new neuronal connections and the strengthening of residual connections through frequent activation after neurological insult are critical for successful rehabilitation of language deficits (Kleim, 2013; Pulvermuller & Berthier, 2008). Even more, use dependence is vital to language rehabilitation after stroke and overcoming learned non-use behavior as infrequent neuronal activation may lead to further loss of synaptic connections in an already compromised brain. Researchers in the fields of CIMT and CIAT have provided neuroimaging evidence of brain plasticity and the recruitment of neocortical neurons after intense constraint-induced treatment (e.g., Liepert et al., 2000; Meinzer et al., 2004; Taub et al., 1999). Therefore, CIAT protocols that call for the repeated use of the affected spoken communication modality and limit the use of other forms of communication are essential to defeat learned non-use of spoken communication.

Language Shaping. The third founding principle of CIAT, language shaping, is accomplished by establishing linguistic goals that are in the upper limits of an individual's ability or what one can achieve with maximal effort. Language shaping also calls for the use of effective cues and reinforcement to attain increasingly demanding linguistic goals (Coelho, Sinotte, & Duffy, 2008) over the course of the treatment (e.g., Difrancesco et al., 2012; Pulvermuller et al., 2001; Szaflarski et al., 2008). Pulvermuller and colleagues (2001) first described language shaping for its application in CIAT as "…a gradual transition from the communicative behavior that initially is characteristic of a patient to progressively improved linguistic behavior" (p. 1622). The success of the spoken communication experienced by people with aphasia, especially when their linguistic productions are shaped by clinicians through effective cueing, may motivate them to continue speaking and generalize the behavior to real-life conversational settings (e.g., Difrancesco et al., 2012; Faroqi-Shah & Virion, 2009; Johnson et al., 2013; Pulvermuller & Roth, 1991). Therefore, language shaping during CIAT programs can be thought of as providing cues and positive reinforcement to condition linguistic behavior.

The principle of language shaping is based on the notion of errorless learning as well as principles of operant conditioning, first discussed by B. F. Skinner (1938; 1957). Skinner described shaping as a technique to condition behavior through the use of reinforcements when he stated, "…the behavior through which the individual deals with the surrounding environment and gets from it the things it needs…is *shaped* up by the environment…" (Skinner,1957, p. 1). Even before Skinner, Thorndike (1898) argued that when behaviors are reinforced they become more likely to reoccur (even undesirable behaviors such as learned non-use). In relation to language rehabilitation after stroke, CIAT aims to allow people with aphasia to learn to make an association between an increase in their spoken language and the reward of communicative success through effective shaping. Thus, language shaping is not only implemented by setting goals and providing effective cues to achieve those goals, but by creating an environment that positively reinforces spoken communicative behavior so people with aphasia become highly motivated to speak.

During the language shaping process, CIAT protocols employ error-reducing learning techniques to increase the likelihood of Hebbian learning (e.g., Maher et al., 2006). Clinicians utilize error-reducing training techniques in an attempt to eliminate or decrease the amount of errors/mistakes an individual produces so they do not positively reinforce their own errors (Fillingham, Hodgson, Sage, & Lambon-Ralph, 2003). Clinicians implement error-reducing techniques when they provide language shaping cues that allow people with aphasia to successfully achieve linguistic goals that start at a basic level (e.g., one word) and gradually increase in complexity (e.g., complete sentence) with minimal failure (Fillingham et al., 2003). In this way, error-reduced learning builds upon operant conditioning by only positively reinforcing the targeted behavior of spoken expression and negatively reinforcing less desirable behaviors such as learned non-use of spoken communication and non-verbal communication as a substitution for speech. Maher and colleagues (2006) coupled error reduction and language shaping in this way "…participants were encouraged to reduce error as much as possible by only producing a response when they were confident it would be correct, and to use the therapist for help in producing a correct response" (Maher et al., 2006, p. 846). When this reinforcement scheme is implemented it creates many opportunities for the targeted behavior to occur, which leads to a reduction in the amount of spoken errors and an increase in successful spoken communication for people with aphasia. Furthermore, the numerous opportunities that error-reduced learning provides to correctly produce language are likely to enhance the formation of the required neuronal associations needed for the remediation of spoken language through use dependent learning (Kleim & Jones, 2008).

Faroqi-Shah and Virion (2009) examined the influence of language shaping on the linguistic outcomes of people with aphasia by integrating a morphosyntactic cueing hierarchy into a CIAT protocol. They employed an “original” (p.979) CIAT cueing hierarchy to shape spoken productions from level-one, simple active sentences (i.e., “Boy hold apple.” p.982) to level-six, two-sentences consisting of plurality, a polite request and an adjectival description (i.e., “The boy hold two red apples. Bob card please” p. 982). Two participants received the original CIAT cueing paradigm while two other participants received the original CIAT program with the addition of grammatical constraints in the cueing hierarchy, which included the use of a temporal adverb (e.g., yesterday) and correct verb tense. The researchers found that all four participants demonstrated significant changes on four of 16 pre-post treatment analyses of morphosyntactic measures (e.g., proportion of sentences, proportion of well-formed sentences, and accuracy of tense) from 30 utterances elicited through a narrative retell task and conversation. Only one of the two participants who received the grammatical cueing hierarchy made significant improvement on one of the morhphosyntactic measures after treatment. Further linguistic analysis of 30 pre-post utterances revealed no significant change in number of words, type token ratio (TTR) or mean length of utterance (MLU) for the participants. Although, the researchers reported that the participants responded positively to the grammatical cueing hierarchy during the sessions, the morphological constraints did not appear to generalize to the elicited discourse samples.

While Faroqi-Shah and Virion (2009) report on the influence of language shaping in the form of a grammatical cueing hierarchy during CIAT on morphosyntactic and lexical outcome measures, the majority of published CIAT investigations do not include specific information on the cueing paradigms used by clinicians to shape spoken communication. In fact, the specific language shaping cues provided by clinicians to enhance the spoken productions of people with aphasia from one word, simple active sentences to sentences with grammatical complexity are generally not reported in the current literature. Faroqi-Shah and Virion (2009) simply stated "Cues were provided by the therapist (the second author) when deemed necessary" (p. 982). Even Johnson et al. (2013) in an in-depth description of an enhanced protocol of CIAT vaguely describe how the clinicians promoted spoken language during CIAT when saying, "Participants were encouraged to use more words each turn and were also encouraged to use more complex adjectives to describe the items pictured on the cards" (p. 64). Difrancesco et al. (2012) and Attard et al. (2013) provide the most insight into the specific language shaping cues that were given to participants during the CIAT programs. Difrancesco et al. (2012) describe the clinicians' behavior as illustrating, modeling, and providing carrier phrases and utterances throughout the treatment that positively reinforced the participants' spoken utterances. Attard et al. (2013) described the specific cueing hierarchy used by the clinicians (p.108), which consisted of phonemic cues, written cues, and word imitation. At this time, CIAT literature has not made it possible to draw conclusions regarding the influence of language shaping on the linguistic outcomes demonstrated by people with aphasia (Barthel et al., 2008).

Implementation of language shaping through cueing paradigms. One of the most distinctive deficits of aphasia is the inability to recall words (e.g., Kendall et al., 2008). Therefore, clinicians are trained to implement restorative aphasia interventions that promote the recovery of word retrieval and spoken language through lexical cueing paradigms (Coelho et al., 2008). The essence of aphasia therapy has been described as "…the elicitation of a response…with a minimal cue" (Linebaugh, Shisler, & Lehner, 1977, p. 19). Schuell's stimulation approach to the management of aphasia (Schuell, Carroll, & Street, 1955) is a historically-proven intervention style that is widely-applied by clinicians. This therapeutic approach combines multiple cueing types (e.g., auditory and visual stimuli) in a hierarchal order to elicit responses and shape the linguistic behavior of people with aphasia with minimal cues (Coelho et al., 2008). Similar to Schuell's stimulation approach, many lexical retrieval interventions for aphasia, including CIAT, employ a variety of phonemic and semantic cueing techniques to improve spoken production of targeted words (e.g., Coelho et al., 2008; Nickels, 2002; Holland, Fromm, DeRuyter, & Stein, 1996; Wambaugh, Doyle, Martinez, & Kalinyak-Fiszar, 2002).

Cueing hierarchies used to shape language are contingent on the response, meaning prompts are often given in order of effectiveness or from least to most power until the targeted response is elicited (Bandur & Shewan, 2008; Bollinger & Stout, 1976; Linebaugh et al., 1977; Nickels, 2002; Wambaugh et al., 2002). Bollinger and Stout (1976) were the first to define the power of a language-shaping cue as "…the stimulus event strength required to cue a desired response. Attributes that contribute to power are number of input modalities employed…Primary to the definition of power is the ease with which a response is elicited" (p. 42-43). The effectiveness of the type and power of cues utilized to provoke correct word production often varies across people with aphasia (Bandur & Shewen, 2008). Linebaugh and collegues (1977) stated "…power is relative to each individual patient; thus the cueing hierarchy that is appropriate for one patient may not be appropriate for another" (p. 19). Therefore, clinicians often evaluate the language-shaping cues provided during interventions to identify the most effective type and power of cues that promote progress to create individually structured hierarchies for people with aphasia to successfully enhance their spoken language (Coelho et al., 2008; Linebaugh et al., 1977). However, Bandur and Shewan (2008), proposed a hierarchy of most to least powerful language-shaping cues for many people with aphasia, with the most powerful cues being repetition (e.g., "say dog") and the least being generalization cues or a general statement with little information (e.g., "This makes a great gift."). Language-shaping cues can then be presented with increasing or decreasing power along a continuum by clinicians to elicit target responses (Conroy, Sage, & Lambon-Ralph, 2010). Clinicians use an increasing cueing hierarchy method when they provide the least powerful cue first. Then, if the prompt does not elicit the targeted word/s, a language-shaping cue that provides slightly more power is given until the target word/s is/are spoken. Conversely, clinicians may use a cueing hierarchy of decreasing power when they present the most powerful language-shaping cue possible first and then gradually reduce the level of the cues given over the course of treatment (e.g., Bandur & Shewan, 2008; Conroy et al., 2010; Linebaugh et al., 1977; Wambaugh et al., 2002). Therefore, clinicians shape spoken behavior by presenting cues in a successive order of increasing or decreasing power, after an individual has produced an appropriate response. Ideally, people with aphasia will progress in treatment by producing correct responses with fewer and less powerful cues (Bandur & Shewan, 2008). An indicator of progress toward communicative independence is when people with aphasia begin to use less powerful cues to produce connected speech.

Phonologic, visual and semantic language-shaping cueing hierarchies for word retrieval. Clinicians provide phonological prompts by presenting the initial phoneme/s of a targeted word (e.g., "st" for stairs) or even a rhyming word (e.g., sounds like "chairs") to activate phonologic knowledge (Linebaugh et al., 1977; Nadeau, Gonzalez-Rothi, & Rosenbek, 2008; Wambaugh et al., 2002). Wambaugh and colleagues (2002) provide an example of a five-step phonological cueing hierarchy aimed to assist people with aphasia with word retrieval and production. The researchers recommend that cues be presented in order of least to most power (Bandur & Shewan, 2008; Linebaugh et al., 1977) to activate phonological knowledge and stimulate one's lexicon. During step-one, people with aphasia are given a cue with the least amount of power when presented with a picture and requested to name the depicted item. During step-five, the highest level and most powerful, a picture of the targeted item is presented with a spoken model for people with aphasia to repeat (Wambaugh et al., 2002).

Visual cues or auditory-visual cues are presented when people with aphasia are asked to listen to speech while looking at a speakers face. Auditory-visual cues are thought to be more powerful than auditory only cues in which people with aphasia are not provided visual information as the auditory-visual cues provide both semantic information and articulatory placement information for visually salient phonemes (e.g., /b/, /f/, /o/) (Choe & Stanton, 2011). Choe & Stanton recently performed and investigation that explored the effects of auditory-visual and auditory only cues on verbal naming. In order to assess the baseline naming ability of the participants, the authors modified the Porch Index of Communicative Ability (PICA) (Porch, 1981) scoring system. This resulted in a 16-point scale that ranked responses based on the power of the language-shaping cue given. Some of the hierarchical cues included from most to least powerful were: tactile, repeated presentation for word imitation, written word, word shape (i.e., "D_ _" for dog), and semantic, see Choe & Stanton, 2011, p. 987 for the comprehensive list. The researchers concluded that the participants demonstrated greater verbal abilities when auditory-visual cues were provided versus auditory only cues, which strengthens the notion that visual information can be very powerful when eliciting target responses for people with aphasia.

Semantic prompts are similar to phonemic cues in that they are given by clinicians to facilitate word retrieval and production but differ in that semantic cues target word knowledge (Kiran, 2007). Semantic cues convey information that is related to a targeted word's lexical network. It is postulated that semantic cues provoke spoken production for people with aphasia because individuals organize their lexicons by semantic categories and attributes (Kendall et al., 2008; Kiran, 2007). Therefore, when a semantic cue is given (e.g., similar category or characteristic), the prompt activates the semantic network and/or a distributed activation pattern around the targeted word (Kendall et al., 2008; Nadeau et al., 2008; Nadeau, 2001). The word is then strongly activated through a connected network of linguistic knowledge and an individual is theoretically able to retrieve the word for spoken production (Coelho, McHugh, & Boyle, 2000; Nickels, 2002). Semantic cues include descriptions of characteristics (e.g., "a furry four legged pet" for the target dog) and may utilize sentence completion tasks to convey semantically related information (e.g., Target: dog→ "I need a leash to walk my __") to stimulate spoken responses (Nessler, 2013). Semantic-lexical cueing treatments, similar to phonological-lexical cueing treatments, also employ language-shaping cueing hierarchies. Wambaugh et al. (2002) proposed a method for presenting semantic cues (p. 464) from least to most powerful (Linebaugh et al., 1977). The least powerful cues include presenting visual stimuli for confrontational naming, while the most powerful semantic cues include a picture stimulus combined with a semantically loaded sentence or phrase to complete using a target word (Wambaugh et al., 2002).

Discourse level language shaping cueing strategies. Once word production is established with the use of facilitative cueing hierarchies, clinicians implement cueing strategies to progress people with aphasia toward eliciting speech at a higher discourse level, beyond the one word level. The *Sentence Production Program for Aphasia* (*SPPA*) (Helm-Estabrooks &

Nicholas, 2000) is just one well-established treatment program used by clinicians with people with aphasia to increase the linguistic and lexical complexity of connected speech. Throughout the *SPPA*, people with aphasia are encouraged with the cueing strategy of repetition. More specificity, they are required to verbally repeat a variety of probe sentences types (e.g., simple yes/no questions, wh-interrogatives/questions). Also during the program, the cueing strategy of elaboration is employed to help people with aphasia produce the targeted sentences with varying levels of linguistic complexity to complete stimulus narratives on their own (Helm-Estabrooks & Albert, 2004; Helm-Estabrooks & Nicholas, 2000). Response elaboration therapy is another intervention commonly implemented by clinicians to increase the content and length of utterances people with aphasia speak (Kearns, 1985; Wambaugh, Nessler, & Wright, 2013). Clinicians employ the cueing strategy of elaboration when they prompt people with aphasia to provide more information by saying, for example, "Tell me in detail how you would go about…" (Wambaugh et al., 2013, p. 415). Clinicians also use the strategies of reinforcing (i.e. providing feedback on the amount of information supplied) and modeling (i.e., demonstrating the use of self-cues and grammatically complex sentences) to encourage people with aphasia to supply more information at the discourse level during response elaboration therapy (Kearns, 1985; Wambaugh et al., 2013). The same well-established word and discourse-level cueing strategies (i.e., phonemic cues, semantic cues, repetition, elaboration, prompting, and modeling) are incorporated into CIAT protocols by clinicians to enhance the linguistic productions of people with aphasia from single words to simple phrases and beyond. The rationale for providing phonologic, semantic and elaboration cues are grounded in the idea that the connections or networks between phonologic, semantic, and conceptual knowledge can be activated to improve word retrieval and production when stimulated and strengthened (Kendall et al., 2008).

Theories of language processing and production. There are two complimentary models for language comprehension and production; the spreading-activation theory (Dell, 1986) and the parallel distributed processing model (Kendall et al., 2008; Nadeau, 2001). Together they form a theoretical framework for clinicians to generate phonologic, visual, and semantic cues with varying levels of power. Proponents of the spreading activation theory suggest that language comprehension and production can be conceptualized as a network of highly connected linguistic units and rules that represent phonologic, semantic, conceptual, visual, and articulatory-motor knowledge. Theoretically, the activation strength of the network units, representing differing types of linguistic knowledge, determines the language one produces and comprehends (Bock, 1982; Dell, 1986). The parallel distributed processing model further describes individual lexicons as a pattern of explicitly activated units within two or more language domains (e.g., phonologic and concept knowledge) (Nadeau et al., 2008). Therefore, an individual's lexicon for language comprehension and production may be stored as a pattern of connectivity among networks of related units (Dell, 1986; Kendall et al., 2008). For example, comprehension of the concept of "school" may correspond to a specific pattern of active units that represent the phonologic knowledge associated with school, such as sounds like "cool", and units of semantic knowledge related to the idea, such as book bags and computers. Consequently, the strength of the connections that comprise the specific patterns of activation determines which words are understood and spoken through their representative pattern of active units in areas of linguistic knowledge (Dell, 1986; Kendall et al., 2008; Nadeau et al., 2008; Nadeau, 2001).

While these theories do not address exactly how knowledge in these language domains is stored in the brain, there is evidence to support that word meanings are distributed over a multitude of highly integrated neural networks (Nadeau et al., 2008; Pulvermuller & Berthier, 2008). Modern neuroscience has provided information about how neurons function and communicate together (Buonomano & Merzenich, 1998; Pulvermuller & Berthier, 2008) and suggests that "…the brain is best understood as a neural network machine" (Kendall et al., 2008, p. 4). Neuronal networks may create the foundation for all knowledge and the ability to transfer information via parallel distributed processing of active units of information (Dell, 1986; Kendall et al., 2008; Nadeau, 2001; Pulvermuller & Berthier, 2008). Therefore, intact neuronal networks are required for adequate spoken language function (Nadeau et al., 2008). Neuroimaging researchers have shown that recognition and comprehension of language typically activate the centers of language housed in the left perisylvian cortex as well as areas of the premotor cortex involved in speech motor production (Fadiga, Craighera, Buccino, & Rizzolatti, 2002; Hauk, Johnsrude, & Pulvermuller, 2004). In essence, the results of neuroimaging investigations support the notion of a highly integrated network, in which co-activation of many areas of linguistic knowledge occur (e.g., Kim, Karunanayaka, Privitera, Holland, & Szaflarski, 2011; Pulvermuller & Berthier, 2008). Therefore, clinicians aim to ameliorate the linguistic comprehension and production challenges people with aphasia experience by providing phonologic, semantic, and elaboration cues that strongly activate and strengthen the connections between concept, phonological, and semantic knowledge housed throughout the brain post-stroke (Kendall et al., 2008; Nadeau et al., 2008; Nickels, 2002).

Clinician Training. Clinicians are trained to incorporate elements of lexical language-shaping cueing hierarchies and elaboration techniques during CIAT programs to advance the spoken productions of people with aphasia from one word to connected speech (Ball, 2009; Difrancesco et al. 2012). Difrancesco et al. (2012) describes the role of the clinician during CIAT as including "…modeling and shaping, adjustment, introduction and keeping track of patient-specific rules, keeping track of communicative success and failure, possibly in the form of a protocol and most importantly, adjusting their own language activities to most efficiently help patients…" (p. 1331). The researchers state the importance of evaluating participants' progress across types of speech acts and level of utterances they produce throughout CIAT programs to help the people with aphasia to expand their spoken language. They also provide a detailed description of the methods of the request and planning games incorporated into an intensive language-action therapy protocol. However, specific examples of the cueing hierarchies Difrancesco and colleagues (2012) used to shape the spoken output of people with aphasia during the language action games were not reported; this limits the ability of true replication of CIAT across studies. Meinzer and colleagues (2007b) briefly described the training process required to implement CIAT protocols when they examined whether relatives of people with aphasia could be trained to facilitate CIAT in a comparable manner as experienced clinicians. The participants' relatives received two hours of training, which included an introduction to the materials and procedures, instruction on how to constrain communication to the spoken modality, and how to adjust the difficulty of communicative tasks. After this training, the relatives were confident in their ability to administer the CIAT protocol and implemented 10-day CIAT programs under the supervision of experienced clinicians. The researchers concluded that the participants exhibited gains similar to other people with aphasia who underwent CIAT with experienced clinicians and that a two-hour training protocol was sufficient enough for relatives to effectively provide CIAT treatment (Meinzer, Streiftau, & Rockstroh, 2007). While it has been suggested that with guidance from speech-language pathologists, laypersons can function as clinicians during CIAT programs, the role of the CIAT clinician is very complex and difficult for one to become proficient without extensive training or a background in language sciences

(Difrancesco et al., 2012). As such, another clinical training program for the facilitation of CIAT programs calls for three days of intensive training (Ball, 2009). Ball (2009), in an unpublished manual, provides extensive training on how to constrain non-verbal communication modalities to encourage spoken communication and presents a hierarchy for the implementation of communicative and linguistic constraints as people with aphasia progress in treatment. The modes of communication posed to constrain during treatment in order included: (a) augmentative and alternative communication, (b) pointing to pictures, (c) communicative gestures, (d) drawing, (e) writing, (f) sound effects, (g) jargon, and (h) perseverative speech. The clinicians were taught to constrain behaviors by first identifying specific non-communicative behaviors (e.g., communicative gestures, stereotypical utterances) then pointing out the behavior to the people with aphasia and asking them not perform that behavior or repeat themselves without using the unwanted words. For example, if a person with aphasia is using gestures the clinician may say, “ Try to say that again without using your hands” or “ Remember we don’t use gestures” or even “ Try to just say the number ‘5’ instead of counting up to it ‘one, two, three’. Along with recommendations of specific communicative behaviors to constrain, a hierarchy that included phonologic and semantic cueing strategies as well as a manner for assessing the effectiveness of each cue was presented and trained. The cueing hierarchy proposed by Ball (2009) included 10 levels from least to most power with a cue to attend to a task/goal as the first and lowest level of cueing and word imitation as the final and most powerful level of cueing (p. 9). The cueing paradigm goes hand-in-hand with examples of specific linguistic goals that start at the single-word level and progress toward complex sentences (Ball, Grether, Al-fwaress, & Rechhardt, 2006). Although CIAT has become more prominent in aphasia rehabilitation, the clinician training protocols and associated cueing paradigms necessary to facilitate and replicate programs are generally unreported in the present literature.

Documenting Gains in Discourse after CIAT

The extant CIAT literature consistently reports positive treatment outcomes on standardized linguistic measures (e.g., Breier et al., 2006; Kemper & Goral, 2011; Kirmess & Lind, 2011; Kurland et al., 2012; Maher et al., 2006; Pulvermuller et al. 2001; Szaflarski et al., 2008); for a comprehensive review of constrained-induced treatment approaches for aphasia over the past 10 years see Meinzer, Rodriguez, & Gonzalez-Rothi (2012). Nevertheless, relatively few CIAT investigations report outcome measures on connected speech production, which are helpful when drawing conclusions on the potential for the treatment to generalize beyond the clinical setting (Kirmess & Lind, 2011). Maher et al., 2006, reported the first measures of connected discourse after CIAT with a pre-post treatment linguistic analysis of a narrative retell task. The researchers concluded that most of the nine participants showed increases in their connected speech production (i.e., number of words, utterances, sentences and MLUs). However, some increases were minimal and a few of the participants demonstrated a decrease in spoken production. Despite these findings, the post and follow up discourse samples of three of the four participants who received CIAT were qualitatively perceived as superior by naïve listeners (Maher et al., 2006). A subsequent study performed by Szaflarski and colleagues (2008) reported substantial improvements on linguistic measures of a narrative retell task for two out of three people with aphasia following a one-week CIAT program. One participant demonstrated a 31% increase in the number of words produced while another demonstrated a 95% increase. Both participants exhibited a 100% gain in the amount of root words (i.e., forms of words after all affixes were removed) they produced during the narrative retell task.

In contrast, a later investigation by Faroqi-Shah and Virion (2009), (described above) did not report significant changes following their linguistic analysis (i.e., number of words, MLUs, TTRs) of 30 utterances from pre and post-treatment conversational and narrative samples of four people with aphasia who underwent CIAT treatment. Then, in 2011, Kirmess and Lind conducted a study to examine if gains made on standardized language assessments after CIAT treatment translated to increased spoken language production at the discourse level. The researchers conducted linguistic analyses of 200 words from structured participant interviews before and after a two-week CIAT program. They found that each participant demonstrated increases in nouns, MLUs and information units produced but the participants showed no change in verb production (Kirmess & Lind, 2011). Kempler and Goral (2011) noted the limited verb use of people with aphasia and set out to compare a drill-based intervention to a communication-based intervention (i.e., modified CIAT program) to improve verb production. They found that the modified CIAT treatment had a profound effect on verb production for two people with aphasia. Further, the researchers observed an increase in the number of words and utterances produced, as well as improved cohesion during personal narratives retelling (Kempler & Goral, 2011). In summary, CIAT researchers have used a variety of methods to elicit discourse samples before and after CIAT ranging from narrative retell tasks to structured interviews and report mixed results on the linguistic gains people with aphasia exhibit at the discourse level after participation in programs. For this reason, investigations regarding the spoken language people with aphasia produce during CIAT programs and the potential influence of language-shaping through clinician cueing on discourse outcomes are warranted (Meinzer et al., 2012).

Statement of the Problem

Due to the diverse and limited results of the discourse analyses reported in CIAT literature, the field would be bolstered by investigations that analyze the spoken discourse people with aphasia produce during the treatment. People with aphasia may manifest word finding difficulties and verbalize differently during standardized confrontational naming tasks when compared to connected speech contexts (Boyle, 2014). Therefore, the changes and linguistic learning that occur within the structure of the CIAT program may not be fully reflected in the standardized pre- and post-treatment assessments of word retrieval typically utilized by CIAT researchers. Even more, research is needed to identify discourse measures that are able to consistently capture the changes manifested in the connected speech of people with aphasia over the course of CIAT treatment—and whether changes in discourse that occur during CIAT intervention sessions correlate with changes in samples taken outside of the CIAT session (i.e., pre- to post-treatment measures). This knowledge will inform future research and clinicians on the possible learning and generalizability of the treatment to both standardized word retrieval and pre-post discourse outcome measures. To date, no studies have reported on the spoken language produced by people with aphasia during CIAT treatment sessions. This information will illuminate the direct impact of the treatment on discourse, which may be missed in discourse samples taken outside of the context of treatment. Furthermore, the specific language shaping cues clinicians provide during CIAT sessions has yet to be explicitly described in the extant literature. Since shaping is a founding principle of CIAT, it is critical that it be defined and described as it occurs during CIAT programs to promote the development and replication of the treatment. Knowledge regarding the manner in which clinicians implement language shaping will guide clinicians and future researcher to systematically replicate and refine CIAT protocols to be as effective as possible and generate greater linguistic gains for people with aphasia that may generalize to other communicative settings.

Purpose

The goal of this dissertation was to investigate the effect of CIAT on post-stroke language remediation. To achieve this goal, two investigations were conducted and an integrated article dissertation format was adopted. The first study, *"Constraint-Induced Aphasia Therapy: Examining Linguistic Gains in Discourse*" comprises chapter two of the dissertation. The purpose of the first investigation was to examine the effects of a 10-day CIAT program on the spoken discourse produced by people with aphasia over the course of the intervention. Specifically, this investigation aimed to examine and compare the content, complexity, efficiency, and communicative success of the spoken discourse produced by people with aphasia on days 2 and 10 of a 10-day CIAT program. The aim of the second investigation, "*Constraint-Induced Aphasia Therapy: What about Shaping?"* found in chapter three was two-fold. The first goal was to document the types of cues provided by trained clinicians during a CIAT program to promote linguistic gains. The second aim of the study was to investigate changes in the number, type, and power of cues given across a CIAT program. The following research questions were posed and hypotheses tested.

Study 1: Constraint-Induced Aphasia: Examining Linguistic Gains in Discourse

Research Design

This study was conducted as part of a larger investigation, National Institute of Health project "*fMRI of Language Recovery Following Stroke in Adults"* (NIH R01 NS048281) randomized controlled trial (NCT00843427), under primary investigator Jerzy P. Szaflarski, M.D., Ph.D. The University of Cincinnati Institutional Review Board approved it for human research. A repeated measures design was utilized to compare the spoken discourse produced by people with aphasia on days 2 and 10 of a CIAT program. To allow the participants the opportunity to become familiar with the treatment setting, procedures, and communicative expectations, day 1 was not utilized for linguistic analysis. As such, day 2 of the treatment provided a more accurate sample of the participants' baseline linguistic performance. See appendix for operational definitions of the linguistic outcome measures utilized to capture changes in the participants' content, complexity, efficiency, and communicative success.

Research Questions and Hypotheses

Research Question (RQ) #1. What changes transpire in the **content** of the spoken discourse produced by people with aphasia from day 2 to day 10 of a 10-day CIAT program?

Research Hypothesis (RH) #1. People with aphasia will demonstrate a significant increase in the amount of **correct information units (CIUs)**, **total words**, and **type token ratio (TTR)** produced as well as a decrease in the number of **mazes** on day 10 of the CIAT program.

RQ #2. What changes transpire in the **complexity** and **use of correct grammar** spoken by people with aphasia from day 2 to day 10 of a 10-day CIAT program?

RH #2. People with aphasia will demonstrate a significant increase in their complexity of language through larger **mean length of utterances (MLU)** as well as a significant increase in their use of correct syntax demonstrated by an increased number of **true conversational units (True C-Units)** produced on day 10 of the CIAT program.

RQ #3. What changes transpire in the **efficiency** of the spoken discourse produced by people with aphasia from day 2 to day 10 of a 10-day CIAT program?

RH #3. People with aphasia will demonstrate a significant increase in the amount of **CIUs they produce per utterance (CIUs/utterance)** from day 2 to day 10 of treatment.

RQ #4. What changes transpire in the **communicative success** of people with aphasia from day 2 to day 10 of a 10-day CIAT program?

RH #4. People with aphasia will demonstrate a significant increase in the **number of initial successful requests** produced on day 10 of the CIAT program when compared to day 2 of treatment.

Study 2: Constraint Induced Aphasia Therapy: What about Shaping?

Research Design

This study was also conducted as part of the previously mentioned investigation under primary investigator Jerzy P. Szaflarski, M.D., Ph.D. Specifically, this study employed pre-post quantitative analysis from day 2 to day 10 of treatment to determine the types of cues provided by trained clinicians and discover significant differences in the number, type, and power of cues delivered to people with aphasia across a 10-day CIAT program.

Research Questions and Hypotheses

RQ#1. Is there a significant difference in the **number of cues** provided by trained clinicians from day 2 to day 10 of a 10-day CIAT program?

RH#1. There will be no significant difference in the amount of cues provided by the clinicians. Since the clinicians were trained to encourage the people with aphasia to produce spoken language at the upper limits of their capabilities they will provide similar rates of cueing throughout the program.

RQ#2. Is there a significant difference in the **type of cues** provided by trained clinicians from day 2 to day 10 of a 10-day CIAT program?

RH#2. The types of cues provided will significantly shift away from word level cues (i.e., word imitation, choice of two words) to recall or elaboration cues (i.e., semantic function, reminders) over the course of the CIAT program. A change from cues that support word level recall and production to elaboration cues will demonstrate that the people with aphasia are producing more complex utterances and requiring less communicative support.

RQ#3. Is there a significant difference in the **power of cues** provided by trained clinicians from day 2 to day 10 of a 10-day CIAT program?

RH#3. The power of cues provided will significantly move toward less powerful cues over the course of the CIAT program. This will show that the participants are able to produce verbal language at higher levels with a decreased amount support from the clinicians.

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Appendix

Operational definitions of linguistic measures

Correct information units (CIUs) were words that are "intelligible in context, accurate in relation to the picture(s) or topic, and relevant to and informative about the content of the picture(s) or the topic" (Nicholas & Brookshire, 1993, p. 348).

Mazes were "…unwanted, extraneous language material" (Shadden, 1998, p. 27) including, but not limited to, fillers, false starts, and self-talk.

Initial successful requests were defined as a turn in which a participant requested a card without a cue from the clinician that resulted in a response from another participant adapted from (Difrancesco et al., 2012).

Mean length of utterance (MLU) was calculated by dividing the number of morphemes spoken by the number of utterances (Miller et al., 2011).

Total counted words were defined as the number of words an individual speaks during a sample when all mazes (e.g., attempts to correct sound errors, dead ends, false starts and unintelligible words are removed) (Nicholas & Brookshire, 1993).

True conversational units (True C-unit) were defined as the shortest units of discourse that are grammatically punctuated as a sentence and consists of one main clause as well as any attached non-clausal structures; adapted from Hunt 1970, 1965.

Type token ratio was calculated by creating a ratio between the number of total words and the number of different root words (Miller et al., 2011).

Utterances were defined as spoken language bounded by silence.

CHAPTER 2

Constraint-Induced Aphasia Therapy: Examining Linguistic Gains in Discourse

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Abstract

Purpose: The purpose was to examine the effects of a 10-day constraint-induced aphasia therapy (CIAT) program on the spoken discourse produced by people with aphasia.

Method: This investigation was performed as a secondary analysis of a larger randomized controlled trial. The spoken discourse produced by nine consecutively enrolled participants during a CIAT program was examined. Specifically, 200 utterances from the second and last days of treatment were analyzed for content, complexity, efficiency, and communicative success.

Results: Non-parametric analyses revealed that the participants exhibited significant positive gains in the amount of correct information units (CIUs; $p = 0.035$), counted words ($p = 0.012$), true conversational units, ($p = 0.025$), mazes ($p = 0.028$), and CIUs per utterance ($p = 0.012$) produced. In contrast, the results revealed a significant decrease in type token ratio ($p = 0.042$). No significant increases were detected in the participants' mean length of utterance ($p = 0.161$) or initial successful requests ($p = 0.667$) across the treatment.

Conclusion: People with aphasia improved aspects of their spoken language after participation in CIAT. Several discourse measures are sensitive to the linguistic changes that occur during a CIAT program. This knowledge may enhance future CIAT protocols and research.

Key Words: Aphasia, Constraint-Induced Aphasia Therapy, CIAT, Discourse

Constraint-Induced Aphasia Therapy: Examining Linguistic Gains in Discourse

People with aphasia in the acute phase of stroke recovery spend significantly less time engaged in communicative interactions than stroke survivors without aphasia (Godecke, Armstrong, Hersh, & Bernhardt, 2013). Furthermore, evidence suggests that the decrease in social interactions experienced by people with aphasia early in their stroke recovery instigates "learned communicative non-use" (Godecke et al., p. 3). These data support the long-held idea that it may be easier for people with aphasia to avoid interacting with others than to suffer the consequences of unsuccessful spoken communication (Kempler & Goral, 2011; Meinzer, Elbert, Djundja, Taub, & Rockstroh, 2007; Pulvermuller et al., 2001; Szaflarski et al., 2008). To counter the notion of learned non-use, Pulvermuller and colleagues (2001) developed constraint-induced aphasia therapy (CIAT) by adopting three principles from constraint-induced motor therapy: shaping, intensity, and constraint (e.g., Meinzer, Rodriguez, & Gonzalez-Rothi, 2012). Although the mechanism of shaping is not clear, the implementation of intensity and constraint during CIAT has been identified as successful intervention practices to improve the spoken language of people with aphasia (e.g., Kurland, Pulvermuller, Silva, Burke, & Andianoploulos, 2012; Meinzer et al., 2012; Pulvermuller et al., 2001). These three principles are reviewed in the following sections.

Shaping is applied through verbal reinforcement and cues, which serve to condition people with aphasia to produce spoken language with increasing amounts of content, syntactic complexity and/or communicative success over the course of treatment. It is postulated that effective shaping enhances the communicative success experienced by people with aphasia during CIAT which may generalize to other real-life conversational settings (Difrancesco, Pulvermuller, & Mohr, 2012; Faroqi-Shah & Virion, 2009; Johnson et al., 2013). However, the role of shaping has yet to be explicitly reported in the extant literature. Research is needed to describe the shaping cues used by clinicians during CIAT to understand and improve the treatment so people with aphasia may experience greater linguistic gains.

The second principle, intensity, is considered to be an effective element of aphasia rehabilitation that may evoke neural plasticity (Kleim & Jones, 2008). In fact, evidenced-based, systematic reviews have revealed that intensive protocols are associated more favorably with positive changes on language impairment outcome measures (Cherney, Patterson, Raymer, Frymark, & Schooling, 2008; 2010). Constraint-induced aphasia therapy programs were designed to adhere to the principle of intensity by requiring concentrated practice over a short period of time, often including three-to-four hour-long sessions, five days a week, for two weeks (e.g., Difrancesco et al., 2012; Kirmess & Lind, 2011; Maher et al., 2006; Meinzer et al., 2012; Pulvemuller et al., 2001).

The third principle, constraint, is implemented by discouraging the use of non-verbal communicative modalities as a substitution for the verbal modality while encouraging the use of higher levels of spoken language (Difrancesco et al., 2012; Johnson et al., 2013; Meinzer et al., 2012). Maher and colleagues (2006) investigated the effect of limiting communication to spoken utterances when they compared a cohort of people with aphasia who received CIAT to others who received a treatment that employs multimodal communication (i.e., *Promoting Aphasics' Communicative Effectiveness* (PACE) (Davis & Wilcox, 1981). The researchers discovered that the people with aphasia who received CIAT tended to display greater linguistic gains than those who received PACE treatment. However, the researchers cautiously speculated that the further increases made by those who received CIAT were a result of constraining communication to the spoken modality as "the data suggest that there is some aspect of the CILT approach that confers additional benefit (Maher et al., 2006, p. 850)."

Discourse Measures Utilized to Evaluate Aphasia Intervention

Over the past 15 years, positive treatment outcomes on standardized linguistic measures following CIAT have been reported from unblended studies (e.g., Breier, Maher, Novak, & Papanicolaou, 2006; Kemper & Goral, 2011; Kirmess & Lind, 2011; Kurland et al., 2012; Maher et al., 2006; Meinzer et al., 2012; Pulvermuller et al. 2001; Szaflarski et al., 2008). However, only a few CIAT investigations have reported quantitative outcome measures of spoken discourse (Kirmess & Lind, 2011). Standardized aphasia assessment batteries often utilize qualitative ranking scales or perceptual data based on clinician judgment to evaluate spontaneous speech production. Perceptual scales such as those employed by the *Western Aphasia Battery-Revised* (WAB-R) (Kertesz, 2006) picture description task may not be as sensitive as formal linguistic analyses when assessing change in discourse production (Grande et al., 2008).

Historically, many methods have been used to gather data on the ability of people with aphasia to efficiently produce connected speech with adequate content and syntactic complexity after treatment (Boyle, 2014; Cherney, Shadden, & Coelho, 1998). Quantitative linguistic analysis methods generate data for observable behaviors, which allows comparisons within and across groups of people with aphasia (McNeil, Doyle, Tepanta, Hark, & Goda, 2001). Sensitive, reliable, and valid observable measures of content such as correct information units (CIUs), counted words (Nicholas & Brookshire, 1993), and type token ratios (TTRs) (Templin, 1957) have been developed and employed by researchers. Assessments of linguistic complexity frequently include mean length of utterance (MLU) (Miller, Andriacchi, & Nockerts, 2011) and indices of syntactic form (Boyle, 2014) such as T-units (Hunt, 1970; 1965). Several of these aforementioned discourse analysis methods have been reported in a limited number of small-scale CIAT investigations.

Discourse outcomes following CIAT. Constraint-induced aphasia therapy studies have employed a variety of methods to elicit pre-post CIAT discourse samples, which range from narrative retells to structured interviews. Investigators also report mixed results on the linguistic analyses of the pre-post outcome measures. On measures of content, most studies show that the majority of participants demonstrate numerical increases in counted words, root words, utterances, and sentences (e.g., Kirmess & Lind, 2011; Maher et al., 2006; Szaflarski et al., 2008) but not in verb production (Kirmess & Lind, 2011). Investigators report varied results on measures of complexity as often, with in the same study, some participants display an increase in MLU and TTR while others do not (e.g., Faroqi-Shah & Virion, 2009; Maher et al., 2006; Szaflarski et al., 2008; Kirmess & Lind, 2011) after CIAT treatment. Only one study reports significant improvement in morphosyntactic measures for four participants post-CIAT (Faroqi-Shah & Virion, 2009). Overall, the investigations that report quantitative linguistic measures pre-post CIAT intervention are small, ranging from two to four participants. Therefore, no discernable patterns of change in spoken discourse across participants or studies have emerged.

Due to the diverse and limited results of the discourse analyses reported in CIAT literature, there is a clear need for further analyses focusing on investigations that analyze the spoken discourse people with aphasia produce during the treatment. People with aphasia may manifest word-finding difficulties and verbalize differently during standardized confrontational naming tasks when compared to connected speech contexts (Boyle, 2014). Therefore, the learning and changes that occur within the structure of the CIAT program may not be fully reflected in the standardized pre- and post-treatment assessments of word retrieval typically utilized by CIAT researchers. Even more, research is needed to identify discourse measures that are able to consistently capture the changes manifested in the connected speech of people with aphasia over the course of CIAT treatment in order to determine in the future whether changes in discourse that occur during CIAT intervention sessions correlate with changes in samples taken outside of the CIAT session (i.e., pre- to post-treatment measures). This knowledge will inform future research and clinicians on the possible generalizability of the treatment to both standardized word retrieval and pre-post discourse outcome measures. To date, no studies have reported on the spoken language produced by people with aphasia during CIAT treatment sessions. This information will illuminate the direct impact of the treatment on discourse, which may be missed in discourse samples taken outside of the context of treatment. Therefore, the purpose of this study was to examine the effects of a 10-day CIAT program on the spoken discourse produced by people with aphasia over the course of the intervention. Specifically, this investigation aimed to examine and compare the content, complexity, efficiency, and communicative success of the spoken discourse produced by people with aphasia on days 2 and 10 of a ten-day CIAT program.

Method

Research Design

This study was conducted as part of a larger investigation; National Institute of Health project "*fMRI of Language Recovery Following Stroke in Adults"* (NIH R01 NS048281) randomized controlled trial (NCT00843427), under primary investigator Jerzy P. Szaflarski, M.D., Ph.D. and was approved by The University of Cincinnati Institutional Review Board for human research. The larger project employed a prospective research design in which people with aphasia were consecutively enrolled in a CIAT program; pre-post treatment discourse probes were not collected during the larger study. Specifically, the present investigation utilized a repeated measures design to compare the spoken discourse produced by people with aphasia on days 2 and 10 of a CIAT program. To allow the participants the opportunity to become familiar with the treatment setting, procedures, and communicative expectations, day 1 was not utilized for linguistic analysis. As such, day 2 of the treatment provided a more accurate sample of the participants' baseline linguistic performance.

Participants

Individuals with aphasia regardless of age, gender, race, type of stroke, aphasia or motor speech disorder were recruited and consent was obtained. All nine of the participants were adults (*M* = 62 years, *Range* = 55 - 78), native speakers of Standard American English, experienced a left middle cerebral artery cerebrovascular accident, and were greater than one year post-stroke (*M* = 68 months post-onset*, Range* = 18 – 137). Of the nine participants, five were female, two were African American and seven were Caucasian. As determined by the WAB-R Bedside (Kertesz, 2006), the participants displayed a variety of aphasia types (i.e., anomic = 3, conduction = 2, Broca's = 2, and mixed = 1); however, the authors were unable to determine one participant's aphasia type due to limited speech intelligibility (i.e., severe-profound dysarthria). Table 1 displays the participants' demographic information as well as their associated aphasia type and motor speech status.

(insert Table 1 about here)

Materials

Assessment. The participants were screened for study eligibility with the *Revised Token Test* (McNeil & Prescott, 1978) and received a minimum raw criterion score of 11 out of 44 (*Range* = 11- 38). A battery of standardized linguistic assessments was administered to the enrolled participants and included: (a) *Boston Naming Test* (BNT), (b) *Boston Diagnostic Aphasia Examination Complex Ideational Material* (BDAE-CIM) (Goodglass, Kaplan, & Barresi, 2000), (c) *Peabody Picture Vocabulary Test -3* (PPVT) (Dunn & Dunn, 1997), (d) *Controlled Oral Word Association Test* (COWAT), and the (e) *Semantic Fluency Test* (Benton, Hamsher, Rey, & Sivan, 1994).

Motor speech disorder rating scale. The researchers developed a perceptual rating scale to determine the presence of concomitant motor speech disorders (Bunton, Kent, Duffy, Rosenbek, & Kent, 2007; Haley, Jacks, de Riethal, Abou-Khalil, & Roth, 2012). The rating scale included dysarthria ratings, diagnoses, as well as rater commentary (see Appendix A).

Stimulus cards. The stimulus cards were the same as those employed by Szaflarski et al. (2008); see previous article for details. The cards included five decks that depicted a variety of objects including nouns of high- and low-frequency, differing numbers, differing colors, phonemically similar objects and action scenes designed to elicit verb production. The participants placed the stimulus cards on foam holders, which allowed them to manipulate the cards easily as well as create a partial barrier. Since our goal was to facilitate natural social interactions between the participants (Szaflarski et al., 2008) and everyday communication does not include barriers (as described by Pulvermuller et al., 2001); thus, barriers were not employed in this study.

Equipment. A Panasonic PV-GS500 digital video camcorder and a Sony Cyber-shot (mpeg VX dsc-w7) were utilized to digitally record treatment days 2 and 10 of the CIAT program. The Systematic Analysis of Language Transcripts (SALT©, 2010) software was used to facilitate coding and analysis of the dependent measures.

Procedures

Assessment. The participants completed the standardized linguistic assessments, pre- and post-treatment, to generate a basic profile of their language abilities. The tests were given within two weeks of the initiation and completion of the CIAT program. The participants' linguistic profiles are summarized in Table 2. In addition, the bedside version of the WAB-R (Kertesz, 2006) was administered only once (pre-treatment) to determine type of aphasia. The presence or absence of concomitant motor speech disorders was retrospectively assessed by two certified Speech-Language Pathologists using the abovementioned perceptual rating scale (see Appendix A). The naive clinicians watched a two-minute treatment video clip of each participant. Following this clip, the clinicians marked the presence/absence and severity of apraxia and dysarthria. After completion of the scale, each clinician provided her diagnoses, along with a severity rating; additional commentary to describe the diagnoses was provided if the scale did not allow sufficient documentation to support the diagnose/severity ranking. Independent assessment of the clinicians' ratings and diagnoses revealed agreement on five of nine participants. The four discrepancies were only related to the severity of the motor speech disorder, not the presence or absence of dysarthria or apraxia of speech. Therefore, all differences were resolved by averaging the raters' scores together. For example, if clinician-one rated and diagnosed a participant with mild apraxia of speech and clinician-two rated the same participant with moderate apraxia of speech, the first author elected to assign the participant a rating of mild-moderate apraxia of speech. Based on this process, all of the participants displayed a concomitant motor speech disorder, which ranged from mild apraxia of speech to severe-profound dysarthria see Table 1 for the participants' motor speech diagnoses.

(insert Table 2 about here)

Goal-setting. A lead clinician observed and reviewed the linguistic performance of the participants on day 1 of the treatment program to establish individual language goals and identify behaviors that should be constrained over the course of the treatment to promote verbal communication. The clinicians disallowed the following behaviors: (a) augmentative and alternative communication, (b) pointing to pictures, (c) communicative gestures, (d) drawing, (e) writing, (f) sound effects, (g) jargon, and (h) perseverative speech. Once the participants' initial linguistic goals were established, the treating clinicians met daily (i.e., in between sessions and at the end of each day) to collaboratively modify and revise the goals (if necessary) for each participant. These changes were based on their performance, linguistic strengths, and the cueing techniques that were found to be effective (e.g., semantic, phonologic). Similar to their aphasia type and severity, each participant's goals were unique and targeted different aspects of language production (e.g., semantics, syntax). For those people with motor speech disorders, goals were implemented to improve intelligibility (e.g., shorter phrase length, and precise articulation). Prior to each session, the clinicians reviewed with the participants their individual goals. Also prior to the each session, the participants were reminded to avoid using non-verbal means of communication; instead, they were prompted to turn to the clinicians to assist them in accurate, targeted language productions when needed.

CIAT intervention. The protocol followed the procedures outlined by Szaflarski and colleagues (2008) and is briefly summarized here. In essence, the participants engaged in a language game that followed the rules of "Go Fish". They were dealt a set of stimulus cards with the objective of obtaining matching cards from other participants by verbally requesting specific cards until one participant matched all of the cards in his/her hand. The stimulus cards were randomized daily to ensure that each set was used over the course of the program and not replicated during the four, 45-minute treatment sessions. During each session, two-to-three trained clinicians were paired with the participants, such that the clinician to participant ratio was always 1:1 or 1:2. The clinicians were responsible for shaping successful spoken communication by providing effective cues and discouraging the use of nonverbal communication modalities as a substitution for spoken language. The clinicians rotated which participant(s) they were paired with after the first two sessions of each treatment day. Rotating allowed each participant to be exposed to every clinician present on the treatment days.

Setting. The CIAT treatment groups examined in this study consisted of three-to-four people with aphasia. All assessment and treatment sessions occurred in a quiet conference room at a local hospital or a classroom at the University of Cincinnati.

Recording and Transcriptions. Treatment days 2 and 10 were digitally video recorded in their entirety and treatment sessions were transcribed. Transcription began when the first participant initiated a card request and ended after each 45 minute session concluded. Two hundred utterances per participant were sampled evenly across the four treatment sessions, per day, to provide reliable comparison between days 2 and 10 (Heilmann, Nockerts, & Miller, 2010; Miller et al., 2011). Examining utterances from each session allowed the researchers to capture the variety of linguistic content elicited by the stimulus cards. The transcriptions were then transferred into SALT© (2010) for coding and linguistic analysis.

Linguistic Analyses. The participants' discourse samples from days 2 and 10 of treatment were evaluated for linguistic content, complexity, efficiency, and communicative success. Change in spoken content was assessed by coding and calculating the percentage of CIUs, or words that were intelligible and accurate in relation to the picture stimuli (Nicholas & Brookshire, 1993), out of the total counted words. The participants' TTR (Miller et al., 2011), or total words divided by the number of different words produced were also calculated as a measure of diversity in their spoken content. Mazes, or any "unwanted, extraneous language material" (Shadden, 1998, p. 27), provided not only insight into the content, but also the efficiency in which the participants conveyed information. The participants' linguistic complexity was measured by computing their MLU (Miller et al., 2011) and by coding and calculating the percentage of spoken utterances that contained true conversational units (TCunits), or units of discourse that are grammatically punctuated (adapted from the T-Unit; Hunt, 1970; 1965). The efficiency of the spoken discourse produced by the participants was calculated as a ratio of the number of CIUs per utterance. Lastly, the communicative success of the participants was assessed by calculating the percentage of initial successful requests or turns initiated and completed by a participant without cueing from a clinician on day 2 and 10 of the CIAT program. See Appendix B for operational definitions of the linguistic dependent measures.

Reliability. The transcripts were verified by the first author and found to be 97.5% accurate. Cohen's kappa (*k*) analyses were employed to ensure moderate to substantial inter-rater reliability of the dependent measures; with 0.41 – 0.60 being considered a moderate and 0.61 - 0.80 a substantial level of reliability (Viera & Garrett, 2005). This yielded a *k* of 0.56 for CIUs (95% agreement), 0.90 for mazes (95% agreement), 0.87 for TCunits (94% agreement), and 0.57 for initial successful requests (79% agreement). The remaining measures were automatically calculated by the SALT© software.

Statistical Analyses

Since the data are not normally distributed, non-parametric analyses were employed. Two-tailed Wilcoxon related samples signed rank tests were conducted to detect differences in the content, complexity, efficiency, and communicative success of the spoken language the participants produced from beginning to end of the CIAT program, using a significance level of 0.05. Effect sizes were calculated using Cohen's *d;* the cutoffs of small, medium, and large (0.2, 0.5, 0.8) effect, respectively, were adopted for this investigation (Cohen, 1988). Participant 3 was not included in the group analysis as a representative sample of her language ability could not be determined due to the severity of her dysarthria.

Results

Overall, the participants exhibited significant, positive gains in the spoken content they produced over the course of the treatment through an increase in CIUs and counted words, as well as a decrease in the number of mazes they exhibited. The participants also displayed significant gains in the complexity and efficiency of the language they verbalized through an increase in the percentage of TCunits produced as well as an increase in the ratio of CIUs per utterance expressed. No significant increases were detected in the participants MLU or percent of initial successful requests across the treatment program. Finally, the participants displayed a significant decrease in their TTR. This study was mainly concerned with the group performance; however, Table 3 displays the participants' individual performance on the discourse measures from days 2 and 10 of the treatment. Below, the changes found in the participants' content, complexity, efficiency, and communicative success are summarized. The group medians per measure are reported as they were used for comparison in the non-parametric analyses. The group ranges, means, and relevant values from the statistical analyses are summarized in Table 4.

(insert Table 3 about here)

(insert Table 4 about here)

Content

CIUs. The analyses showed a positive gain in the percent of CIUs the participants produced from day 2 (*Median* = 81.3%) to day 10 (*Median* = 88.3%) indicating a significant increase ($p = 0.035$) and a small effect size ($d = 0.28$).

Counted Words. The results indicated that there was a significant increase ($p = 0.012$) in the percent of counted words the participants produced from day 2 (*Median* = 82.7%) to day 10 (*Median* = 88.3%) of the treatment. These results yielded a medium effect size ($d = 0.61$).

TTR. A significant decrease in TTR ($p = 0.042$), with a small effect size of ($d = 0.41$), was observed from day 2 (*Median* = 0.23) to day 10 (*Median* = 0.21) of the CIAT program.

Mazes. A significant decrease in the percent of mazes ($p = 0.028$) the participants exhibited from day 2 (*Median* = 17.0%) to day 10 (*Median* = 12.0%) of the CIAT program was found. This change generated a medium effect size ($d = 0.59$).

Complexity

MLU. The statistical analysis did not reveal a significant increase ($p = 0.161$) in the participants' MLU from day 2 (*Median* = 3.8) to day 10 (*Median* = 4.8) of the treatment. Even though there was no significant increase in the participants' MLU, a positive trend for increased utterance length was indicated by a small effect size ($d = 0.21$).

TCunits. A significant increase ($p = 0.025$) was detected in the percent of TCunits produced by the participants from day 2 (*Median* = 34.8%) to day 10 (*Median* = 50.3%) of the CIAT program. This change was associated with a medium effect size ($d = 0.50$).

Efficiency

CIUs per Utterance. The results indicated that there was a significant increase ($p = 0.012$) in the ratio of CIUs the participants produced per utterance from day 2 (*Median* = 3.0) to day 10 (*Median* = 4.2) of the CIAT program. A small effect size ($d = 0.38$) was also observed for this measure.

Communicative Success

Initial Successful Turns. No significant change ($p = 0.667$) was observed for initial successful turns from day 2 (*Median* = 8.0%) to day 10 (*Median* = 10.0%) of the CIAT program.

Discussion

The aim of this investigation was to examine the gains people with aphasia exhibit over a two-week CIAT program in the spoken discourse they produce. The results indicate that the participants made positive gains in their spoken discourse, despite varying types of aphasia and severity of concomitant motor speech disorders. However, the authors were unable to determine how the treatment may have impacted the spoken discourse of Participant 3, who presented with severely limited intelligibility secondary to dysarthria. The significant gains manifested in the content, complexity, and efficiency of spoken language produced by this small group of participants are particularly encouraging for people with chronic aphasia, because they demonstrate the advances in verbal expression that can take place in the chronic stages of stroke recovery.

Discourse Measures Sensitive to Positive Changes Following CIAT

The participants in this study displayed significant increases in the percent of CIUs, counted words, TCunits, and ratio of CIUs per utterance from the beginning to the end of the treatment on discourse samples taken during the CIAT intervention sessions. The participants also displayed a significant decrease in the number of mazes they experienced, indicating improvements in the content, complexity, and efficiency of their speech. These data are congruent with previous research that reports advances in the spoken discourse (e.g., number of words, number of utterances, information units) produced by individuals on post-treatment discourse samples who received CIAT (e.g., Kempler & Goral, 2011; Kirmess & Lind, 2011; Maher et al., 2006; Szaflarski et al., 2008). Therefore, the measures of CIUs, counted words, mazes, and CIUs per utterance appear sensitive enough to capture changes during pre-post discourse assessments and treatment. Additionally, Boyle (2014) recently reported that the number of CIUs, percent of CIUs, number of T-units and word-finding behaviors are sufficiently consistent on test-retest stability measures to be used as reliable outcome measures in group research designs for people with aphasia. Based on these findings, she argued that measures need to be sensitive enough to capture changes in discourse and display test-retest stability to provide evidence that variations found are a result of treatment and not inconsistencies within the measures themselves. Therefore, future studies adopting these measures will allow researchers and clinicians to correlate the changes manifested in the participants' spoken productions during the treatment to pre-post-treatment discourse activities. This will be important in identifying measures that best document generalization from discourse production during CIAT intervention to other communicative settings.

Discourse Measures that May Display Positive Gains Following CIAT

The participants in this study did not demonstrate significant increases on all the dependent linguistic measures. In fact, the analysis of the TTR data revealed that the measure is sensitive enough to demonstrate change and indeed displayed a significant decrease for the participants in this study. Upon further examination of the individual performances of the participants, five of the eight participants displayed decreases in their TTR while the other three displayed no change. Faroqi-Shah and Virion (2009) found comparable results when they reported no difference in the TTR data produced by four people with aphasia post CIAT treatment. The decrease in TTR displayed by the participants in this project may be an artifact of the intervention. Since the same sets of stimulus cards were rotated throughout the program, a wide variety of language may not have been elicited beyond the specific targeted cards. For example, the card deck conveying differently-color objects was small in that it only contained 18 different targets (e.g., white feather, yellow bucket). While the card deck of phonemically similar words was larger, it still depicted only 89 targets. Of note, the same decks of stimulus cards were not compared from day 2 to day 10, due to the random assignment of card decks to treatment sessions, so the same amount of targets were not prompted on both days. Consequently, there was less variety in the available targets to begin with on day 10 of the treatment and the results of the analysis were likely affected. The stimulus cards utilized on day 2 elicited an average 508 tokens from the participants while the card decks employed on day 10 of the treatment elicited an average 418 tokens from the participants.

To combat the limited diversity of language elicited by the stimulus cards, transfer packages, which offer practical methods of increasing linguistic diversity and verbal engagement outside the clinic setting can be implemented. It is suggested that an important element allowing people with aphasia to integrate the positive linguistic gains made during CIAT treatment into everyday communication activities is the application of transfer packages (Johnson et al. 2014). Transfer packages and CIAT-plus programs involve family members and caretakers of people with aphasia to engage individuals in as much communication as possible outside of the clinic setting by including exercises to be performed independently or with a communication partner, the completion of language worksheets, communication skill assignments at home and in the community, and communication problem-solving for daily tasks (i.e., how to overcome barriers to speaking in specific situations) (e.g., Meinzer, Djundja, Barthel, Elbert, & Rockstroh, 2005;

Johnson et al., 2013). Perhaps, forthcoming CIAT protocols that incorporate diverse transfer packages as executed by Johnson et al. (2014) could shed light on the ability of diversity measures to capture linguistic changes in a variety of settings (as compared to discourse produced during the CIAT intervention sessions). Future research that explores several types of discourse to elicit a variety of language (e.g., story retells, interviews, and conversation samples) pre- and post-treatment may provide a more accurate TTR measure to evaluate improvements in the diversity of spoken language exhibited by those who receive CIAT. An accurate measure of lexical diversity is important as it provides insight into the word retrieval and production abilities of people with aphasia at the discourse level, in that as word retrieval improves a wider variety of words are produced (Boyle, 2014).

All but one participant (i.e., Participant 2) exhibited a numerical increase in their MLU, even though no statistically significant increase was detected in the group analysis. This finding is similar to the results of the MLU data presented by Maher et al. 2006, who found that three out of the four participants who received CIAT demonstrated increases in their MLU post-treatment. Participant 2 started the program with a relatively high MLU (i.e., 7.7). Throughout the program, the clinicians encouraged her to produce shorter utterances to increase the intelligibility of her spoken language, because of her dysarthria. Therefore, on the surface, this participant appeared to show a relatively large decrease (i.e., 2.17) in her MLU. Though, when her individual motor speech goal is accounted for, she likely made a noteworthy improvement in her intelligibility at the cost of a lower MLU. As such, it is important to consider the individualization of goals and shaping of the participants' language production when discussing outcome measures, especially when concomitant motor speech disorders necessitate goals that directly impact outcomes of complexity.

The number of initial successful requests made by the participants remained stable over the course of the CIAT program. The lack of change on this measure may be a direct result of how the clinicians facilitated the intervention protocol. For instance, in an effort to encourage the people with aphasia to be successful in their initial verbal requests, the clinicians may have frequently provided shaping cues to ensure the overall success of the participants' turn. Without further inquiry into the manner in which clinicians provide shaping cues, it is unknown how the initial success and other linguistic measures of the participants' speech are affected by the principle of shaping. Meinzer et al. 2012 posits that shaping may play a larger role and effect treatment outcomes more than the principles of intensity and constraints (Morris, Taub, & Mark, 2006). To date, little to no research has explicitly examined the contributions of shaping in the form of clinician cueing during CIAT.

Limitations and Future Directions

Interpretation of the results of this project for clinical implications should be performed with caution as there were several inherent limitations. Research that incorporates a larger number of participants, as well as a control group for discourse analysis, will provide needed information on the specific advances in verbal discourse that people with aphasia experience as a direct result of participation in CIAT. Also since pre-post treatment discourse measures were not collected as part of the larger investigation, discourse analyses could only be conducted on the spoken language produced during the treatment sessions. This may under or overestimate the generalizability of the findings to types of discourse that occur outside of intervention, such as narrative retells or conversational discourse. Future studies that integrate a larger range of discourse types, such as conversational, narrative, and expository language tasks pre- and post-treatment will allow for associations to be made between discourse measures sampled during treatment. Comparing the discourse outcomes of participants during CIAT treatment to pre- post-treatment discourse measures may guide future researchers and clinicians to further refine outcome measures and CIAT protocols to facilitate generalization via transfer packages and modification of individual participant goals.

Furthermore, this study would have been strengthened by including a pre-post-treatment standardized aphasia assessment such as the WAB-R (Kertesz, 2006). If a full aphasia battery had been given as opposed to the short bedside screening at the pre-treatment session, then the researchers could investigate whether the changes displayed at the discourse level were captured by the standardized test. Faroqi-Shah and Virion (2009) found the WAB-R aphasia quotient (Kertesz, 2006) to be the most sensitive post-treatment standardized measure utilized in their investigation to capture changes in aphasia type and severity. Even more, without the full WAB-R (Kertesz, 2006), this investigation is limited in how it can be compared to previous research that reports WAB-R aphasia quotients (Kertesz, 2006) (e.g., Faroqi-Shah, & Virion, 2009; Kempler, & Goral, 2011; Johnson et al., 2014; Maher et al., 2006).

Although the researchers were able to retrospectively classify the participants' motor speech disorders (or lack thereof), an oral motor exam with accompanying evaluation of concomitant apraxia of speech and/or dysarthria would apprise researchers and clinicians on the impact of the severity of motor speech disorders on the performance of people with aphasia during and after CIAT. Participant 3, who had severe-profound dysarthria, did not respond well to the treatment. In fact, she became so fatigued over the course of the program that her already diminished level of intelligible speech became nearly incomprehensible by day 10. On the other hand, Participant 9, who displayed moderate-severe apraxia of speech responded well to the treatment. He exhibited positive or stable gains on every discourse measure. Since aphasia rarely occurs without some level of motor speech involvement (Patterson & Chapey, 2008), it is important that this issue is addressed in the CIAT literature. One investigation accounted for the severity of the apraxia of speech of two participants who received CIAT. The results suggest that CIAT has a positive impact on word retrieval and production for people with aphasia and moderate-severe apraxia of speech (Kurland et al., 2012). It is with caution that this investigation draws a similar conclusion based on the retrospective diagnosis and rating of the participants' concomitant motor speech disorders. To ensure a positive response to CIAT, forthcoming studies could utilize more stringent motor speech disorder inclusion criteria (i.e., no more than moderate dysarthria and moderate-severe apraxia of speech).

It is also worth mentioning that seven different clinicians with variable experience levels (i.e., 0 years to 10 years) facilitated CIAT for three groups over three years. Therefore, the same clinicians were not always present on days 2 and 10, which were utilized for the discourse comparisons reported in the current study. Even though the clinicians received the same training, the clinicians' experience, personality, style of providing shaping cues, and manner of reinforcing the participants' verbal behavior may have impacted the discourse outcomes exhibited by the participants. It is speculated that the individual shaping provided by the clinicians influenced the outcomes the people with aphasia experienced through the amount of communicative support provided. Future investigations that examine the specific shaping cues and the manner in which they are provided by clinicians to facilitate CIAT programs are greatly needed to illuminate the role of shaping in CIAT.

Despite the heterogeneous small sample size, the participants, as a group, demonstrated significant advances in the content, complexity, and efficiency of their verbal discourse over a 10-day CIAT program. The results of this study thus provide additional evidence to promote the efficacy of CIAT. Researchers and clinicians may discover the findings and dependent measures explored useful when sharpening protocols to enhance the verbal abilities of people with aphasia. Future refinement of CIAT conventions and outcome measures that promote closer approximations to natural discourse (Maul, Conner, Kempler, Radavanski, & Goral, 2014) will greatly increase the magnitude of the intervention on the communication of people with aphasia.

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Table 1

Participants' Demographic Data

Participant	Gender	Race	Age	Months post onset	Education Level	Revised Token Test [a]	Aphasia Type [b]	Motor Speech Disorder
1	Female	Caucasian	55	124	AD [c]	11	Mixed	Mild Apraxia
2	Female	Caucasian	78	48	MA [d]	37	Anomic	Mild Dysarthria
3	Female	African American	69	45	-	38	Unable to differentiate	Severe-profound Dysarthria
4	Male	Caucasian	61	137	JD [e]	37	Anomic	Moderate Dysarthria, Mild Apraxia
5	Male	Caucasian	56	41	BA [f]	11	Broca's	Mild-moderate Apraxia
6	Male	Caucasian	55	73	BA [f]	37	Conduction	Mild-moderate Dysarthria, Mild Apraxia
7	Female	African American	56	83	GED [g]	38	Anomic	Mild Dysarthria, Mild Apraxia
8	Female	Caucasian	69	18	HS [h]	12	Conduction	Mild Apraxia
9	Male	Caucasian	67	39	BA [f]	17	Broca's	Moderate-Severe Apraxia

Note: [a] *Revised Token Test* (McNeil & Prescott, 1978) possible score 44, [b] *Western Aphasia Battery-Revised* (WAB-R) *Bedside* (Kertesz, 2006), [C] Associates Degree, [d] Master of Arts, [e] Juris Doctorate, [f] Bachelor of Arts, [g] General Educational Diploma, [h] High School. - denotes unavailable data.

Table 2

Participants' Assessment Data

Participant	BNT [a]		BDAE-CIM [b]		Semantic Fluency Test		COWAT [c]		PPVT [d]	
	pre	post	pre	post	pre	post	pre	post	pre	post
1	35	39	6	6	15	24	10	12	88	94
2	57	56	12	11	39	44	21	22	103	106
3	55	52	12	12	-	14	-	8	101	118
4	57	59	11	12	38	41	12	19	95	114
5	33	34	6	8	14	16	2	3	92	85
6	58	60	6	9	30	35	15	15	99	103
7	25	27	8	8	26	23	8	6	78	72
8	11	20	7	9	3	6	3	3	91	94
9	9	9	10	10	10	13	4	9	118	104

Note: [a] *Boston Naming Test* (BNT) possible score 60, [b] *Boston Diagnostic Aphasia Exam-Complex Ideational Material* (BDAE-CIM) possible score 12 (Goodglass, Kaplan, & Barresi, 2000), [c] *Controlled Oral Word Association Test* (COWAT), (Benton, Hamsher, Rey, & Sivan, 1994), [d] *Peabody Picture Vocabulary Test* (PPVT) standard scores (Dunn & Dunn, 1997) possible score 240. - denotes unavailable data.

Table 3

Individual Performance on Discourse Measures: Comparison of Day 2 and Day 10

Participant	% CIUs [a]		% Counted Words		TTR [b]		% Mazes [e]		MLU [c]		TCunits [d]		CIUs per Utterance		Initial Successful Turns	
	Day 2	Day 10	Day 2	Day 10	Day 2	Day 10	Day 2	Day 10	Day 2	Day 10	Day 2	Day 10	Day 2	Day 10	Day 2	Day 10
1	91	95	82	88	.23	.23	18	12	3.38	4.23	30	47.50	2.90	3.83	8	8
2	94	98	94	96	.21	.14	6	4	7.70	5.53	63	80	6.80	7.3	4	1
4	83	88	85	88	.22	.22	15	12	4.74	5.32	39.50	55	3.70	5.1	9	2
5	73	77	69	80	.29	.27	31	20	1.9	2.4	17	21.50	1.32	1.79	8	11
6	93	94	86	89	.28	.28	14	11	4.99	5.28	45.50	53	4.26	4.6	5	10
7	79	89	84	90	.22	.21	16	10	4.21	6.16	54.50	80	3.17	5.29	8	11
8	80	76	74	81	.23	.15	26	19	2.79	3.14	27.50	25	2.10	2.27	9	12
9	60	62	53	68	.24	.22	47	32	1.72	2.19	18	18.50	0.97	1.31	11	10

Note: [a] Correct Information Unit (CIU), [b] Type Token Ratio (TTR), [c] Mean Length of Utterance (MLU), [d] True Conversational Units (TCunits). Participant 3 was excluded from the analyses because a true representation of her language could not be captured due to severe-profound dysarthria.

Table 4

Group Performance on Discourse Measures: Comparing Day 2 and Day 10 of CIAT

Dependent Measure	Day 2 Median	Day 2 Range	Day 2 Mean	Day 10 Median	Day 10 Range	Day 10 Mean	Wilcoxon *Z*	*p*	Cohen's *d* [a]
CIUs [b]	81.3	52.7 - 93.6	81.5	88.3	67.9 – 95.8	84.8	-2.11	**0.035**	0.28
Counted Words	82.7	60.0 – 94.0	78.3	88.3	62.4 – 98.0	85.0	-2.52	**0.012**	0.61
TTR [c]	0.23	0.21 – 0.29	0.24	0.21	0.15 – 0.28	0.21	- 2.03	**0.042**	0.41
Mazes	17.0	6.0 – 47.0	15.0	12.0	4.0 – 32.0	10.0	- 2.20	**0.028**	0.59
MLU [d]	3.8	1.25 – 7.70	3.9	4.8	2.12 – 6.16	4.3	-1.40	0.161	0.21
TCunits [e]	34.8	17.0 – 54.5	36.9	50.3	18.5 – 80.0	47.6	-2.24	**0.025**	0.50
CIUs per Utterance	3.0	0.97 – 6.80	3.1	4.2	1.31 – 7.30	3.90	-2.52	**0.012**	0.38
Initial Successful Turns	8.0	4.0 – 11.0	7.8	10.0	1.0 – 12.0	8.1%	-.430	0.667	0.10

Note: All data reported in percentage of occurrence, with the exception of TTR, MLU, and CIUs/utterance. Data in bold were significant at $p < .05$, two-tailed. Participant 3 was excluded from the analyses as a true representation of her language could not be captured due to severe-profound dysarthria. [a] small effect size ≤ 0.2, medium effect size ≥ 0.5, large effect size ≥ 0.8. [b] Correct Information Unit (CIU), [c] Type Token Ratio (TTR), [d] Mean Length of Utterance (MLU), [e] True Conversational Units (TCunits).

Appendix A

Perceptual rating scale to determine presence of concomitant motor speech disorders

1) Sound Substitutions

1	2	3	4	5
Normal	Mild Impairment	Moderate Impairment	Marked Impairment	Severe Impairment

2) Imprecise Consonants

1	2	3	4	5
Normal	Mild Impairment	Moderate Impairment	Marked Impairment	Severe Impairment

3) Revisions

1	2	3	4	5
Normal	Mild Impairment	Moderate Impairment	Marked Impairment	Severe Impairment

4) Repetitions

1	2	3	4	5
Normal	Mild Impairment	Moderate Impairment	Marked Impairment	Severe Impairment

5) Prolongations

1	2	3	4	5
Normal	Mild Impairment	Moderate Impairment	Marked Impairment	Severe Impairment

6) Abnormal Stress

1	2	3	4	5
Normal	Mild Impairment	Moderate Impairment	Marked Impairment	Severe Impairment

7) Slow Rate

1	2	3	4	5
Normal	Mild Impairment	Moderate Impairment	Marked Impairment	Severe Impairment

8) Restricted Pitch Variation

1	2	3	4	5
Normal	Mild Impairment	Moderate Impairment	Marked Impairment	Severe Impairment

9) Inconsistent Errors

1	2	3	4	5
Normal	Mild Impairment	Moderate Impairment	Marked Impairment	Severe Impairment

(Bunton, Kent, Duffy, Rosenbek, & Kent, 2007; Haley, Jacks, de Riethal, Abou-Khalil, & Roth (2012).

Total Numeric Score: ____________

(a) No impairment = 0 - 9 (b) Mild = 10 -18 (c) Moderate = 19-27 (d) Moderate-Severe = 28 -36

(e) Severe = 37 - 45 (f) profound = 45 with rater commentary

Overall Diagnosis (including presence/no presence of disorder, type, severity)**:**

Additional Comments:

Definitions of Speech Characteristics

Sound substitutions	Bilabials and alveolar consonants less frequently in error; affricates and fricatives more frequently in error
Imprecise consonants	Distortions and perceived substitutions tend to be close to target features
Revisions	Speakers often aware of articulatory errors, can sometimes predict them, and often attempt to correct them
Repetitions	Sound and syllable repetitions
Prolongations	Prolonged consonants and vowels
Abnormal stress	Equalized stress across syllables and words
Slow rate	Rate for utterances more than one syllable in length is usually slow
Restricted pitch variation	Restricted or altered pitch, durational, and loudness contours within utterances
Inconsistent errors	Same sounds not always in error; error types not always the same in specific utterances

Note: Definitions adapted from Duffy, J. R. (2013). *Motor speech disorders: Substrates, differential diagnosis, and management.* St. Louis, MO: Mosby.

Appendix B

Operational definitions of linguistic measures

Correct information units (CIUs) were words that are "intelligible in context, accurate in relation to the picture(s) or topic, and relevant to and informative about the content of the picture(s) or the topic" (Nicholas & Brookshire, 1993, p. 348).

Mazes were "…unwanted, extraneous language material" (Shadden, 1998, p. 27) including, but not limited to, fillers, false starts, and self-talk.

Initial successful requests were defined as a turn in which a participant requested a card without a cue from the clinician that resulted in a response from another participant adapted from (Difrancesco et al., 2012).

Mean length of utterance (MLU) was calculated by dividing the number of morphemes spoken by the number of utterances (Miller et al., 2011).

Total counted words were defined as the number of words an individual speaks during a sample when all mazes (e.g., attempts to correct sound errors, dead ends, false starts and unintelligible words are removed) (Nicholas & Brookshire, 1993).

True conversational units (True C-unit) were defined as the shortest units of discourse that are grammatically punctuated as a sentence and consists of one main clause as well as any attached non-clausal structures; adapted from Hunt 1970, 1965.

Type token ratio was calculated by creating a ratio between the number of total words and the number of different root words (Miller et al., 2011).

Utterances were defined as spoken language bounded by silence.

CHAPTER 3

Constraint-Induced Aphasia Therapy: What about Shaping?

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Abstract

Background: Constraint-induced aphasia therapy (CIAT) was developed to overcome learned verbal non-use for people with aphasia. It is based on the principles of intensity, constraint, and shaping. Intensity and constraint have been clearly defined and examined in the literature, which suggests that these two elements play an important role in facilitating linguistic gains for people aphasia through CIAT. In contrast, the notion of shaping has not been clearly defined, especially in terms of how clinicians shape (or cue) targeted linguistic behaviors during CIAT programs. This knowledge is needed in order to explore the specific impact shaping has on observed CIAT outcomes.

Aims: The purpose of this study was two-fold: (1) to illuminate the types of cues provided by trained clinicians during a CIAT program to promote linguistic gains for people with aphasia and (2) to investigate changes in the number, type, and power of cues given across a CIAT program.

Methods & Procedures: This study was conducted as a secondary analysis of a larger randomized controlled trial (NCT00843427) under PI: Jerzy P. Szaflarski, M.D., Ph.D., and utilized a repeated measures design. Seven clinicians were trained to facilitate a CIAT program. Transcripts from treatment sessions occurring in the middle of days 2 and 10 of a 10-day CIAT program were coded for 11 types of cues. Each cue type was assigned a level of power. Non-parametric statistical testing was used to detect significant differences in the number, type, and power of cues provided by the seven trained clinicians across the CIAT program.

Outcomes & Results: No significant differences between days 2 and 10 of the CIAT sessions in the number, type, and power of cues given were detected. Further inspection of the raw data revealed a trend for more cues to be provided at the end of the CIAT program than the beginning.

Conclusions: Specific changes in the type and power of cues provided during the course of a CIAT program were not detected. However, the same cue types were utilized to elicit different targets. This investigation broadens the definition of CIAT shaping and provides a framework for investigating the impact of shaping on the outcomes experienced by people with aphasia following CIAT.

Key words: Aphasia, Constraint-Induced Aphasia Therapy, Cueing, Shaping

Constraint-Induced Aphasia Therapy: What about Shaping?

Constraint-induced aphasia therapy (CIAT) is designed to overcome learned non-use of spoken communication for people with aphasia, which is based on three principles: intensity, constraint, and shaping (e.g., Meinzer, Elbert, Djundja, Taub, & Rockstroh, 2007; Meinzer, Rodriguez, & Gonzalez-Rothi, 2012; Pulvermuller et al., 2001; Szaflarski et al., 2008). Consistently, evidence supports the notion that intensity is a critical component of aphasia intervention and one of the primary reasons for the documented effectiveness of CIAT (e.g., Barthel, Meinzer, Djundja, & Rockstroh, 2008; Cherney, Patterson, Raymer, Frymark, & Schooling, 2010; Maher et al., 2006; Meinzer, Djundja, Barthel, Elbert, & Rockstroh, 2005; Pulvermuller et al., 2001). The extant literature has also identified the constraint of nonverbal communication as a key element of CIAT (e.g., Maher et al., 2006; Difrancesco, Pulvermuller, & Mohr, 2012). In contrast, the influence of shaping (or cueing) on the linguistic gains experienced by people with aphasia after CIAT remains largely unknown (Barthel et al., 2008). Since shaping is tailored to meet the individual needs of people with aphasia, it is possible that it has an even more pronounced effect on outcomes than treatment intensity or constraint of nonverbal communication (Meinzer et al., 2012).

What is Shaping?

The concept of shaping originated from operant conditioning as a method to train desired behavior(s) through reinforcement (Skinner, 1957; Thorndike, 1898). Pulvermuller and colleagues (2001) defined the principle of shaping for the context of constraint-induced language therapies as a dimension of constraint, "… (shaping is) a gradual transition from the communicative behavior that initially is characteristic of a patient to progressively improved linguistic behavior" (p. 1622) and occurs in small steps or "successive approximations" (p.

1622). During CIAT, people with aphasia are encouraged to produce utterances with predetermined linguistic elements, just above their current ability and use levels of verbal language that they may, in other circumstances, avoid. As a result, shaping in the CIAT literature is typically discussed in the context of encouraging people with aphasia to produce progressively more advanced levels of syntactic complexity (e.g., Attard, Rose, & Lanyon, 2013; Difrancesco et al., 2012; Faroqi-Shah & Virion, 2009; Johnson et al., 2013; Kempler & Goral, 2011; Maul, Conner, Kempler, Radavanski, & Goral, 2014; Pulvermuller et al., 2001; Szaflarski et al., 2008). Generally speaking, lower levels of syntactical hierarchies begin at the single word level (e.g., “ball”), then progress to simple sentences (e.g., “The boy plays ball.”) and eventually progress to more complex sentence structures (e.g., “The boy plays ball in the park.”). However, reports rarely describe exactly when and how the verbal behavior of people with aphasia is shaped (or cued) through positive reinforcement to meet these linguistic targets.

One study reported that shaping was provided when deemed necessary (Faroqi-Shah & Virion, 2009). Another paper loosely described how clinicians promoted more complex language: “Participants were encouraged to use more words each turn and were also encouraged to use more complex adjectives to describe the items pictured on the cards” (Johnson et al., 2013, p.64). A recent study summarized that the CIAT clinicians prompted people with aphasia to produce targets with reminders and word imitation models (Maul et al., 2014). Nevertheless, a few CIAT investigations have reported on the cues clinicians utilized during programs to shape more complex spoken language for people with aphasia. Kempler and Goral (2011) broadly described the cues used in their investigation as “scaffolding” (p. 1344) which included: “(1) general prompt, (2) more specific prompt, and (3) a model for repetition” (p. 1344). Attard et al. (2013) supplied the most insight into the specific cues utilized by clinicians to implement a modified CIAT program when they described a cueing hierarchy for naming that consisted of phonetic and written cues, as well as word imitation prompts. Aside from these studies, the majority of published CIAT investigations does not include sufficient information on the specific cues used to shape the linguistic targets, and thereby advance the verbal productions of people with aphasia. This highlights the importance of precisely defining and describing the cueing system that clinicians utilize during CIAT programs. For this reason, the authors propose that the definition of the principle of shaping be expanded to include the cues clinicians utilize to expand the spoken language of people with aphasia.

Cueing Hierarchies in Aphasiology

Shaping through clinician-provided cues is not a new idea; historically, aphasiologists have combined multiple cueing types (e.g., phonologic and semantic) in a hierarchical order to elicit responses and shape the linguistic behavior of people with aphasia (e.g., Coehlo, Sinotte, & Duffy, 2008; Nickels, 2002; Holland, Fromm, DeRuyter, & Stein, 1996; Wambaugh, Doyle, Martinez, & Kalinyak-Fliszar, 2002). The known effectiveness of phonologic and semantic cueing in eliciting correct productions in people with aphasia is often attributed to the spreading-activation theory (Dell, 1986) and the parallel distributed processing model for word comprehension (Kendall et al., 2008, Nadeau, 2001). These theories posit that when knowledge in one language domain is activated (i.e., phonologic), the connecting language domains of knowledge (e.g., concept, semantic knowledge) are also activated to varying degrees. Therefore, the strength of the connections between linguistic domains determines which words are retrieved and spoken (Dell, 1986; Kendall et al., 2008; Nadeau, Gonzalez-Rothi, & Rosenbek, 2008; Nadeau, 2001). Thus, clinicians provide phonologic and semantic cues of varying strengths during therapy to stimulate the connections between phonologic, semantic, and concept representation knowledge (Nickels, 2002) to facilitate word retrieval and production (Kendall et al., 2008; Nadeau et al., 2008).

Phonologic and semantic cues are classically provided by clinicians in a hierarchical order of power until the targeted response or behavior is elicited (Bandur & Shewan, 2008; Conroy, Sage, & Lambon-Ralph, 2010; Linebaugh, Shisler, & Lehner, 1977; Wambaugh et al., 2002). The stimulus power of a cue was first described by Bollinger and Stout (1976) who defined power as "…the stimulus event strength required to cue (or shape) a desired response. Attributes that contribute to power are number of input modalities employed…Primary to the definition of power is the ease with which a response is elicited (p. 42-43)". Later, Bandur and Shewan (2008), proposed a hierarchy of most-to-least powerful cues, with the most-powerful cue being repetition and the least-powerful being a generalization cue, or a statement with little information (e.g., "Some people eat these for breakfast." Target: "eggs"). Although a plethora of phonologic and semantic cueing hierarchies proliferate the aphasiology literature (e.g., Wambaugh et al., 2002), discrepancy exists regarding whether cues should be provided from least-to-most, or most-to-least powerful (Abel, Schultz, Radermacher, Willmes, & Huber, 2005). No matter the approach, clinicians must present cues in a sequential order, based on the response a person with aphasia produces. More specifically, if the initial prompt provided does not elicit the target response, a cue that provides slightly more (or less) power is given until the targeted word/utterance is spoken (Bandur & Shewan, 2008; Conroy et al., 2010; Linebaugh et al., 1977; Wambaugh et al., 2002). Given the historical implementation and rich descriptions of shaping through cueing in aphasiology, shaping in relation to CIAT should also be detailed.

Purpose

To date, the literature has yet to reveal, with any degree of clarity, *how* clinicians shape (cue) the targeted syntactical utterances of people with aphasia during CIAT. It is imperative then, that shaping be clearly defined and described to allow research to explore the influence shaping may have on the treatment outcomes experienced by people with aphasia.

The knowledge of how clinicians apply shaping through cues will allow CIAT programs to be systematically replicated. Only then, can conclusions regarding the role of shaping in CIAT be made. Therefore, the expanded definition of shaping should include the original notion of encouraging people with aphasia to produce increasingly more complex linguistic structures along a syntactic hierarchy, as well as the specific cueing hierarchies clinicians employ to achieve this goal. Well-developed cueing hierarchies may make it possible for people with aphasia to demonstrate linguistic gains and a higher level of communicative independence by requiring fewer and less powerful cues over the course of CIAT programs. For the current study, it was hypothesized that, at the end of a 10-day CIAT program, people with aphasia would require fewer cues and clinicians would shift from more- to less-powerful cues. Thus, the purpose of this exploratory study was to: (a) characterize the types of cues provided by trained clinicians during a CIAT program, and (b) determine whether there were significant differences in the number, type, and power of cues given across a 10-day CIAT program.

Method

Research Design

This study was conducted as part of a larger investigation; National Institute of Health project "*fMRI of Language Recovery Following Stroke in Adults*" (NIH R01 NS048281) randomized controlled trial (NCT00843427), under primary investigator Jerzy P. Szaflarski, M.D., Ph.D. and was approved by The University of Cincinnati Institutional Review Board for human research. The bigger project utilized a prospective research design in which people with aphasia were consecutively enrolled and clinicians were trained to facilitate a CIAT program. Specifically, pre-post quantitative analysis from day 2 to day 10 of treatment was employed to detect differences in the number, type, and power of cues delivered by clinicians who completed the training. Day 1 treatment sessions were not utilized in the analyses to allow the people with aphasia and clinicians the opportunity to become accustomed to each other, to the treatment procedures, and allow a lead clinician to establish linguistic goals.

Participants

Seven clinicians facilitated the CIAT program to three different groups of people with aphasia and provided consent. All of the clinicians were Caucasian females, had a wide range of experience (*M* = 4 years, *Range* = 0 - 10), and their percent of practice dedicated to working with adults with aphasia was variable (*M* = ~ 40%, *Range* = 0 - 100). Table 1 provides the demographic information for the clinicians. Of note, since there were seven clinicians who facilitated three CIAT groups, the same clinicians were not always present on days 2 and 10 of the treatment; this is highlighted in Table 1.

(insert Table 1 about here)

People with aphasia. Nine people with aphasia were consecutively enrolled in the CIAT program and formed three treatment groups as part of the larger investigation. All were adults (*M* = 62 years, *Range* = 55 - 78), five were female, two were African American and seven were Caucasian. Each were native speakers of Standard American English and experienced a left middle cerebral artery cerebrovascular accident greater than one year prior to enrollment (*M* = 68 months post-onset, *Range* = 18 – 137). They displayed a variety of aphasia types (i.e., anomic

= 3, conduction = 2, Broca's = 2, and mixed = 1) as determined by the WAB-R Bedside (Kertesz, 2006); however, the authors were unable to determine one participant's aphasia type due to limited speech intelligibility (i.e., severe-profound dysarthria). Table 2 displays the demographic information, aphasia type, motor speech status and linguistic goals and day 2 and 10 of the treatment for each person with aphasia.

(insert Table 2 about here)

Materials

Stimulus cards. The CIAT stimulus cards included six card decks that depicted a variety of objects including high- and low-frequency nouns, numbers, colors (e.g., red, yellow, green colored common nouns, 'red bucket'), phonemically similar objects, and action scenes (designed to elicit verb production). The same decks were employed by Szaflarski et al. (2008). The stimulus cards were placed on card holders, which allowed the people with aphasia to manipulate the cards in instances of concomitant hemiparesis. Similar to the authors' earlier work (Szaflarski et al., 2008), barriers as described by Pulvermuller (2001) were not used during the CIAT sessions. The rationale for eliminating this practice was to facilitate natural social interactions between the people with aphasia.

Equipment. Two digital video camcorders (i.e., a Sony Cyber-shot mpeg VX dsc-w7, Panasonic PV-GS500) were used to record treatment days 2 and 10 of the CIAT program. The Systematic Analysis of Language Transcripts (SALT©, 2010) software was employed to facilitate coding and analysis of the number, type, and power of cues provided.

Procedures

The CIAT training and therapeutic sessions occurred in a quiet conference room at a local rehabilitation hospital or a classroom at the University of Cincinnati.

Clinician Training. The clinicians received training over a three day period following a protocol developed by Ball (2009).

Training day 1. During the first training session, the clinicians were presented with an overview of constraint-induced language based therapies and the theoretical framework of CIAT. Current research findings on CIAT outcomes were also discussed. The clinicians then watched sample videos of CIAT programs to become familiar with the basic dynamics and procedures.

Training day 2. The second session focused on the implementation of constraint and establishing individual goals.

First, all communication during the treatment needed to be constrained to the verbal modality. Therefore, the use of non-verbal communication modalities was not allowed. The clinicians were trained to identify the following communicative behaviors to constrain: (1) augmentative and alternative communication, (2) pointing, (3) communicative gestures, (4) drawing, (5) writing, and (6) sound effects. Also, limited was the use of jargon, repeated non-communicative word(s) and any other communicative behavior that detracted from the efficient verbal communication of targeted utterances.

Second, a variety of stimulus cards were employed to elicit words and utterances that people with aphasia may in other circumstances avoid (Pulvermuller et al., 2001). The clinicians were taught to consider the six decks of cards as applying a type of linguistic constraint. In other words, in order for the people with aphasia to successfully play the game and obtain card matches, they had to use a variety of nouns, verbs, and adjectives to adequately describe what was depicted on the cards.

Next, the clinicians were instructed to provide opportunities for successful communication through shaping and cueing and establish linguistic goals. Once the baseline linguistic abilities of the people with aphasia were identified, the clinicians were educated to encourage the participants to produce more advanced syntactic forms along a six-level hierarchy (see Appendix A). The first level was a single word with no morphological ending; the final and highest level, included complex sentences with prepositional phrases and embedded clauses. The clinicians were to give cues to encourage the people with aphasia to produce their individual linguistic targets along the continuum while providing more meaningful content to their utterances. However, the clinicians were taught, if the intention of the participants' utterances resulted in positive and successful communication from the other people with aphasia that this was more important to the intervention than using targeted and accurate syntax. This would theoretically allow the participants to increase feelings of success through positive reinforcement while increasing motivation to continue using spoken language to overcome learned non-use.

The notion of reinforcement was also presented. Reinforcement was used to discourage undesirable behaviors (e.g., gesturing) and encourage desirable behaviors (e.g., verbal expression). The clinicians were educated to provide positive reinforcement (e.g., "Well done; great describing word." or "I noticed you pointed, try to say that again without pointing.") to create an environment in which the people with aphasia felt successful and motivated to continue using increasingly complex spoken language. Reinforcements were tailored to each person with aphasia so that they received positive encouragement when they met they produced the linguistic targets established for them. For example, if a person with moderate aphasia had a goal of producing two-to-three word utterances, they received positive feedback for using verbal communication that included their individually targeted linguistic content such as another's name, an adjective, an object, and politeness (e.g., "John, big dog please").

The last topic presented on day 2 of training was how to establish individual language goals for the people with aphasia. The clinicians were trained to first determine goals by identifying the linguistic strengths and level of utterances a person with aphasia was capable of producing. Then, refer to the syntactic hierarchy to establish a goal that is one level higher than the typical utterances exhibited by the person with aphasia. For example, if the person with aphasia could produce two-word utterances such as an adjective and a noun (e.g., "yellow ball") then their goal would be to produce three-word utterances such as adjective + noun + verb (e.g., "yellow ball bounce"). During goal development, the clinicians also identified any non-verbal behaviors to constrain and if a person with aphasia was observed using a non-verbal communication strategy, a goal would be created to decrease that behavior.

Training day 3. On day 3 of the training the clinicians learned how to shape or implement cues to promote verbal expression and advance people with aphasia through the aforementioned linguistic continuum. A hierarchy of 11 cues were provided in order from least-to-most linguistic power and included: (1) request attention, (2) reminder, (3) semantic function, (4) semantic phrase completion, (5) phonetic with visual oral, (6) phonetic with visual hand sign, (7) phonetic first phoneme(s), (8) choice of two similar words, (9) choice of two dissimilar words, (10) word imitation and (11) other, or any cue that does not fit into one of the aforementioned cue types such as a constraint cue or articulatory placement cue. The clinicians were trained to follow the cueing hierarchy with increasing power (or from least-to-most power) and provide cues either when the people with aphasia displayed anomic behavior, or when they did not produce their linguistic target. After the cueing hierarchy was introduced, the clinicians were provided the opportunity to practice identifying behaviors to constrain (from day 2 training), identifying linguistic targets, and implementing the cueing hierarchy through role play.

Next, the clinicians were taught to use a cue tracking tool. This tool was utilized to tally the type of cues provided and determine which types were most effective during the treatment sessions. This information was used as an aid when tailoring the linguistic goals and cueing levels for each participant (Appendix B). The clinicians were instructed to review the tool after each 45-minute session and at the end of each treatment day (see below for CIAT protocol details) to look for patterns of successful and unsuccessful cues. This process allowed the clinicians to make evidence-based decisions on how to adjust goals and cueing levels for each person with aphasia for the next session and/or the next day of therapy.

Finally, special issues such as rotating clinicians/people with aphasia at the half-way point on each treatment day and breaks were discussed. Rotating the clinicians for each session ensured that each clinician worked with each person with aphasia to reduce fatigue and encourage greater social dynamics within the group. The clinicians were instructed to look for signs of fatigue such as lack of attention and need for higher levels of cueing during the treatments sessions. If people with aphasia were displaying such signs then they were to suggest that the group take a short break. Lastly, the clinicians were provided further opportunity to review treatment videos, role play constraining behaviors, providing cues as well as practice using the cue tracking tool (Ball, 2009).

Goal-setting. A lead clinician observed the linguistic performance of the people with aphasia on the first day of the CIAT program to aid in identifying behaviors to constrain and create individualized language goals based on their linguistic strengths. Once initial goals were established, the treating clinicians met throughout the treatment program (see next section) to discuss and determine if the individual language goals needed to be modified.

CIAT Intervention. The intervention procedures followed those employed by Szaflarski et al. (2008). The CIAT program lasted 10 days and included four, 45-minutes sessions each treatment day (total treatment time = 30 hours). In brief, the treatment consisted of a language game in which people with aphasia were dealt a set of stimulus cards with the objective to verbally request cards with increased linguistic difficulty over the course of the program in order to acquire cards, until all were paired. The picture stimulus cards followed a pre-determined randomized block design; each deck was used throughout the program and not repeated (i.e., used twice) on any given treatment day. During each 45-minute session, two clinicians were matched with one or two people with aphasia to shape successful spoken requests and interactions by providing cues. The clinician-to-person with aphasia ratio was either 1:1 or 1:2, depending on the treatment group size. At the start of each treatment session, the clinicians reminded the people with aphasia of their individual linguistic goals and any behaviors to avoid (e.g., finger spelling). The clinicians rotated which people with aphasia they were paired with between sessions two and three of each treatment day to ensure each clinician worked with each person with aphasia. During the treatment sessions, the clinicians tallied the type and success of the cues provided by the other clinician using the cue tracking tool (Appendix B).

Recording, Transcription, and Sampling. Treatment days 2 and 10 were digitally recorded and treatment sessions two and three were transcribed from each day. The transcripts were verified in their entirety by a member of the research team, and found to be (97.5%) accurate. These particular sessions were selected for two of reasons. First, coding the sessions that occurred in the middle of the treatment day allowed for an accurate illustration of the people with aphasia and clinicians' performances to be captured by accounting for influences of a 'warm-up' period (session 1) or fatigue (session 4). Second, coding multiple sessions per treatment day provided an opportunity to examine the variety of cues the clinicians employed across different sets of stimulus card decks. Day 2 included the numbers, verbs, and common nouns decks, while day 10 employed the common nouns, verbs, phonemically similar nouns, and colored stimulus cards. Analysis of these sessions also allowed the researchers to capture any differences in the types of cues the clinicians provided to the people with aphasia when they rotated who they were paired with between sessions two and three.

Dependent Measures. The transcripts were coded using SALT (SALT©, 2010) software for the number, type, and power of cues provided to the people with aphasia. The coded cues were based on the cueing hierarchy trained by Ball (2009) (see Appendix B). Pre-coding checks revealed that other cues typically included constraint cues and articulatory placement cues. Thus, the cue category of "other" from the Ball (2009) hierarchy was removed and constraint and articulation cues were coded in its place. The cue types of phonetic with visual oral and phonetic with visual hand sign were collapsed to create one category, phonetic cue with visual model. Also collapsed into one cue type, choice of two words, were choice of two similar words and choice of two dissimilar words. Therefore, 11 types of cues were examined in this study from least-to-most power: (1) request attention, (2) reminder, (3) constraint cue, (4) semantic function, (5) semantic phrase completion, (6) semantic reminder, (7) phonetic cue with visual model, (8) phonetic cue first phoneme(s), (9) articulatory placement, (10) choice of two words, and (11) word imitation.

Each cue type was assigned and coded with a corresponding level of power. The operational definition of the level of power a cue conveys was adapted from Bollinger and Stout's (1976). To expand the definition and explicitly delineate the stimulus strength that a cue provided, differing levels of power were derived from the number of areas of cognitive-linguistic knowledge stimulated by the specific types of cues. These determinations were based on the parallel distributed processing model of language (Kendall et al., 2008; Nadeau, 2001). Also taken under consideration, was the cognitive load the cue placed on the person with aphasia (Bollinger & Stout, 1976). Hence, the level of power offered by a cue was defined by the number of areas of language knowledge stimulated and the relative amount of cognitive processing the cue required. So that, if a cue required greater cognitive processing relative to other cue types that stimulated the same language knowledge areas, it was deemed to carry less stimulus power. Said differently, if a cue necessitated very little cognitive processing, then it conveyed a higher level of power. Appendix C provides operational definitions for each cue type, examples from the CIAT treatment sessions, and the assigned level of power for each cue type.

Reliability. Videos of the treatment days were transcribed verbatim into word processing software, verified in their entirety by a member of the research team, and found to be (97.5%) accurate. Cohen's kappa (*k*) analysis (Cohen, 1988) was employed to ensure a moderate level (i.e., 0.41 – 0.60) of interrater reliability (Viera & Garrett, 2005) among the coding of the type and power of cues given. The analysis yielded a *k* of 0.58 (86% agreement).

Statistical Analyses

This investigation aimed to explore changes in the number, type, and power of cues provided by clinicians over the course of a CIAT program. Since the data are not normally distributed, non-parametric analyses were employed. To test for differences in the number, type, and power of cues provided from day 2 to day 10 of the CIAT program, two-tailed Wilcoxon related samples signed rank tests were completed with significance level, 0.05. In order to employ the non-parametric analysis to detect differences in the power of cues given by the clinicians, the weighted power of each cue type needed to be calculated. The weighted level of power for each cue type was determined by multiplying the assigned level of power given to a cue type by its percent of the grand total of cues. For example, the cue type "choice of two words" had an associated level of power of "5" and comprised 10% of the grand total of cues provided on day 2 of treatment. Therefore, the percentage "10" was multiplied by the level of power "5" to yield a weighted level of power of 50.

Results

Number of Cues

The analysis indicated no significant decrease ($p = 0.249$) in the number of cues given by the clinicians from day 2 (*Median* = 75.0) to day 10 (*Median* = 67.0) of the treatment (Table 4). Table 3 summarizes the individual clinician data regarding the types and frequency of cues they provided on days 2 and 10 of the CIAT program. Inspection of the raw data revealed that a greater raw number of cues were provided on day 10 (i.e., 578) than on day 2 (i.e., 404). Also, it was revealed that there was a propensity for the clinicians with higher (i.e., 5 – 10 years) and lower (i.e., 0 years) levels of experience to provide more frequent cues across the program. Clinicians 1, 4, and 7 had the most experience and displayed a propensity to provide cues frequently as a group, ($M = 140$ day 2, $M = 139$ day 10). The student clinicians without experience (i.e., Clinician 5 and 6) gave a relatively high number of cues during the treatment sessions, (i.e., Clinician 5 = 90, day 2, Clinician 6 = 153, day 10). In contrast, the clinicians who had 3.5 – 4 years of experience (i.e., Clinicians 2 and 3) together provided cues with the lowest frequency, ($M = 39$ day 2, $M = 38$ day 10). However, upon further scrutiny of the two clinicians who were present on both treatment days during group 1 (i.e., Clinician 1 and 2), a decrease in the amount of cues they provided on day 10 was found (i.e., Clinician 1, day 2 = 84 cues, day 10 = 64 cues; Clinician 2, day 2 = 66 cues, day 10 = 17 cues).

(insert Tables 3 & 4 about here)

Type of Cues

The paired Wilcoxon related samples signed rank analyses detected no significant ($p \leq 0.05$) differences in the frequency of use for each type of cue provided by the clinicians from day 2 to day 10 of the CIAT program. In other words, the clinicians provided each type of cue at similar rates at the beginning and the end of the program. Table 3 provides the medians, means, and relevant values from the statistical analyses for each type of cue examined.

Power of Cues

No significant decrease, ($p = 0.779$), in the overall weighted power of the cues provided by the clinicians was revealed from day 2 (*Median* = 21.0) to day 10 (*Median* = 18.0) (Table 3). Table 5 presents the raw data for each cue type, the assigned level of power, and the calculated weighted level of power for each type of cue on day 2 and 10.

(insert Table 5 about here)

Discussion

The goal of this investigation was to document the types of cues provided by trained clinicians during a CIAT program to shape the verbal behavior of people with aphasia. Changes in the number, type, and power of cues given on days 2 and 10 of a 10-day CIAT program were examined. Although no significant differences in the number, type, and power of cues provided by the trained clinicians across the program were identified; inspection of the raw data revealed several trends that may help direct future studies designed to examine the role of shaping, specifically in the form of cueing, on CIAT outcomes. Limitations that may have affected the results are also reviewed.

Number of Cues Provided

Review of the raw data revealed that, in general, the clinicians provided more cues on day 10. At first glance, this seems contrary to the hypothesis that people with aphasia will display linguistic improvement and greater communicative independence by requiring fewer cues to produce successful utterances at the end of a CIAT program. However, this finding may be a direct result of the training the clinicians received and the intervention. The clinicians were taught to develop new and more complex linguistic goals throughout the program, to ensure that the people with aphasia continued to produce spoken language at the upper limits of their capabilities. In other words, the higher number of cues provided on day 10 may have been required to assist the people with aphasia in producing more complex utterances, because linguistic goals become more demanding over the course of CIAT programs (e.g., Johnson et al., 2013; Maul et al., 2014). Collecting baseline data on the number of cues required each time a new linguistic goal is established would allow for a comparison of the cues needed when established and achieved.

The fatigue of the participants with aphasia could have affected the number of cues needed as well; however this could not be teased out in this retrospective study. Anecdotally, on day 10 of the treatment, the researchers observed the people with aphasia commenting that they were tired, though this was not specifically assessed. As a result, they may have required more communicative support or linguistic cues toward the end of the CIAT program. It is not uncommon for people with aphasia to exhibit fatigue over the course of intensive treatments (e.g., Rodriguez et al., 2013). Indeed, one person with aphasia and concomitant severe-profound dysarthria, in this study, became so exhausted over the course of the program that her speech was nearly unintelligible on the last day of the treatment. This factor could have not only influenced the number of cues provided, but also the type and power of the cues given as well.

Clinician Characteristics

The clinicians appeared to behave differently in regards to how frequently they provided cues, which corresponded to their experience level. Both the experienced clinicians and student clinicians provided the most cues on days 2 and 10. It has been argued that the clinician's role during CIAT programs is complex and may be difficult for individuals who do not have a background in language sciences or experience working with people with aphasia to become proficient facilitators without a great deal of training (Difrancesco et al., 2012). Hence, the experienced clinicians may have been more adept at identifying anomic behaviors and so, knew when to give and/or not to give a cue. During the coding process, the researchers anecdotally observed that the experienced clinicians had a higher level of comfort interacting with the people with aphasia. Since the students in this study were just learning how to work with people with aphasia, they presumably presented cues by modeling the behavior of the other, more experienced clinicians. The experienced clinicians most likely provided support to the students by "scaffold-*ing*" (Austin, 2013, p. 87) their clinical learning. In addition, out of fear of not supporting people with aphasia, the novice clinicians may have erred on providing too many cues versus not enough. It appears then, that experience may influence the number of cues given. Reasonably, clinicians may create their own style of shaping over time which may be difficult to change despite training and perhaps influenced the data. Treatment fidelity checks to provide a measure as to how closely the clinicians followed the trained shaping protocol throughout the intervention would have enhanced the internal validity of this study (Hinckley & Douglas, 2013), thus increasing the likelihood of future replication.

Another contributing element to the differences noted in the amount of cues provided may be that the same clinicians were not always present on days 2 and 10. This investigation would have been strengthened by the ability to examine and compare the behaviors of the same clinicians across the program, which is an unavoidable limitation as this study was conducted as a secondary analysis. The larger investigation purposefully rotated the clinicians do to the high-intensity and extensive time commitment needed to conduct the CIAT programs. When the same clinicians were compared from day 2 to day 10 (i.e., Clinicians 1 and 2) a tendency to provide fewer cues on day 10 emerged. Therefore, it may be important for the same clinicians to be present throughout CIAT programs. Future research that utilizes designs that allow the same clinicians or clinicians with similar characteristics to be analyzed across CIAT programs would permit individual clinician characteristics such as level of experience and percent of clinical practice spent working with people with aphasia to be accounted for and will reveal how clinicians may influence shaping.

Type and Power of Cues Provided

Overall, a reminder cue was the most frequent cue type provided by the clinicians—on days 2 and 10 — and was followed by phonetic first phoneme(s), word imitation, and semantic phrase completion, respectively. As a group, the clinicians rarely utilized constraint, articulatory placement, semantic function, or request attention cues. Therefore, the clinicians consistently provided both recall and elaboration cues (i.e., reminder, semantic phrase completion) and word level cues (i.e., phonetic first phoneme(s), choice of two words) at similar rates from beginning to end of the program. Inspection of the raw data did not reveal any discernable patterns regarding shifts in the types of cues the clinicians employed from day 2 to day 10. However, while the types of cues did not change over the course of the program, the linguistic targets did

(See Table 2). In other words, the same types and power of cues were employed by the clinicians to elicit varying levels of language from the participants on day 2 and day 10. In fact, excerpts from transcripts between Clinician 1 and a participant with aphasia 'Jamie' show that Clinician 1 gave the same type of cues to provide models and elicit different linguistic goals across the program. On day 2, Clinician 1 utilized a semantic phrase completion cue and a reminder cue to assist Jamie in word retrieval and the use of the carrier phrase "Do you have __?".

Clinician 1: "*I will start it for you. Do you have ...*" (Semantic Phrase Completion Cue)

Jamie: *"Ears."*

Clinician 1: *Now say the whole thing."* (Reminder Cue)

Jamie: *"Do you have two ears?"*

Then on day 10, Clinician 1 also used a reminder cue to prompt the use of an interrogative sentence.

Jamie: *"I have the elephant's t truns trunk..."*

Clinician 1: *"Can you follow that up with a question?"* (Reminder Cue)

Jamie: *"Um, give me the trunk?"*

Forthcoming investigations could further evaluate and compare how similar cues are given to prompt different targets (e.g., single words, nouns, verbs, prepositional phrases) to shed light on the possible connections between cue types and specific linguistic targets.

Since the calculated weighted level of power for each cue type is associated with its frequency of use, the power of cues provided remained stable across the CIAT program. These results are contrary to the hypothesis that the cue types provided by the clinicians would move from word level to recall or elaborations cues, so that the overall level of the power of the cues provided would decrease. The largest change detected in the cue types was in the number of phonetic first phoneme(s) cues provided from day 2 to day 10 with an increase of 7%. Since this cue type carried a high-level of power and was provided more frequently on day 10, the statistical analysis may have been influenced when the weighted levels of power were calculated and compared. However, much of this increase can be attributed to Clinicians 1, 2, and 7. These clinicians demonstrated the highest average percentage of phonetic first phoneme(s) cues individually given at 17%, 25%, and 21% of their total cues, respectfully on day 10 (Table 2). Interestingly, these clinicians had more years of experience and/or the highest percent of their practice devoted to working with people with aphasia (i.e., Clinicians 2 and 7 at 41-100%). Again, experienced clinicians may find it difficult to overcome previously established clinical practice behaviors (Cabana et al., 1999) to adopt and implement a newly trained cueing paradigm, such as the cueing hierarchy Ball (2009) utilized in this study. This strengthens the argument that individual clinician characteristics may influence the manner in which shaping is implemented.

Influence of Motor Speech Disorders on Cues

This investigation did not differentiate between cues intended to provoke word recall and word production to determine whether cues move away from the word level (i.e., word imitation, choice of two words) over a treatment program. Word recall cues are given to stimulate one's concept knowledge and lexicon, whereas word production cues are provided to stimulate articulatory-motor knowledge in order to aid the planning and intelligible articulation of targeted words. In fact, often the same type of cue may be given to elicit the recall, planning and production of words, such as those employed by the *Combined Aphasia and Apraxia of Speech Treatment* (Wambaugh, Wright, Nessler, & Muszycki, 2014), modeling, repetition and articulatory placement. Individuals with apraxia of speech have more difficulty in word planning and production than recall (Duffy, 2013), but they benefit often from word level cues such as word imitation to assist in verbal execution. All of the individuals with aphasia in this investigation displayed a concomitant motor speech disorder ranging from mild apraxia of speech or dysarthria to moderate-severe apraxia of speech and severe-profound dysarthria. Table 6 presents the demographic information and motor speech disorders exhibited by the people with aphasia who took part in the three CIAT groups. Visual inspection of the coded transcripts from the three CIAT groups revealed that the clinicians who were paired with the people with aphasia who displayed a motor speech disorder with at least moderate severity, tended to give the highest number of articulatory placement, choice of two words, phonetic first phoneme(s) and word imitation cues. This is particularly apparent in the cueing behavior of Clinicians 1 and 2 who were paired with a person with aphasia, (i.e., Mary) who displayed severe-profound dysarthria in group 1 and Clinician 2's behavior during group 2 who provided a relatively high percentage of phonetic first phoneme(s) cues to a gentleman with mild-moderate apraxia of speech, (i.e., Jack). Also, Clinicians 4, 5, 6, and 7 used a comparatively large percentage of phonetic first phoneme(s) and word imitation cues to facilitate word planning and execution for a gentleman who exhibited moderate-severe apraxia of speech (i.e., George) in group 3 of the CIAT program. Since, this investigation did not distinguish between cues that were utilized to elicit both word production and recall, it is not possible to determine whether the people with aphasia demonstrated linguistic gains through a decrease in the number of word level cues required over the course of the treatment. Comparing the individual linguistic and verbal production goals of people with aphasia to the cue types they receive, with special attention to cues given for word planning and production versus word recall, may shed light on the influence motor speech disorders have on the number, type, and power of cues provided to individuals throughout CIAT programs.

Influence of Stimuli on Type and Power of Cues

A drawback of this study is that the same stimulus cards were not compared from day 2 (i.e., numbers, verbs, and common nouns) to day 10 (i.e., verbs, common nouns, phonemically similar nouns, and colors). It is feasible that the various stimulus card decks influenced the number, type, and power of cues the clinicians provided on days 2 and 10. Since the stimulus cards were designed to provoke diverse language, they include a range of semantic categories. Therefore, knowledge in different language domains such as semantic and conceptual knowledge (Dell, 1986; Kendall et al., 2008, Nadeau, 2001) may have been stimulated with varying strengths by the card decks themselves. Thus, the cues the clinicians gave during treatment sessions to elicit responses may have depended on which stimulus decks were employed. In other words, the clinicians provided prompts that stimulated knowledge in language domains that were either not activated, or not stimulated powerfully enough by the cards. For example, when the card deck of verbs was employed the clinicians may have provided a higher number of semantic reminder and semantic function cues (e.g., "What is the man doing?" or "I do this when I clean." Target: "sweep") during the session to strongly activate semantic knowledge to strengthen the connections between the semantic, concept, and articulatory-motor knowledge needed for word (verb) retrieval and production (e.g., Kendall et al., 2008). In contrast, during a session that utilized phonemically similar nouns, the clinicians may have provided a higher number of phonetic first phoneme(s) and articulatory placement cues. These cues strongly activate phonologic and articulatory-motor knowledge and would be particularly supportive during a treatment session that requires people with aphasia to produce targeted words precisely in order to successfully receive matches from others. (e.g., “Do you have a mop?” versus “ Do you have a top?”). Future research that aims to reveal differences in the frequency of cue types provided across treatment could employ research designs that allow for the same stimulus cards to be compared across programs to account for any variation in the type and frequency of cues given when differing sets of stimulus cards are employed.

Conclusion

This investigation expands the definition of CIAT shaping to include the particular cues clinicians employ to promote the production of more complex spoken language. By examining the specific number, type, and power of cues provided by clinicians, this study provides a framework for future studies to investigate the effect shaping may have on linguistic outcomes. To date, the full impact of shaping on the linguistic gains people with aphasia experience after CIAT remains elusive. This study revealed that CIAT shaping provided by clinician cueing may simultaneously promote language and speech planning and execution – skills necessary for stroke survivors to become functional independent communicators. To further advance the field, researchers and clinicians could adopt a new conceptualization of CIAT that does not view language and speech production intervention as mutually exclusive but rather holistically as post-stroke communication rehabilitation.

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Appendix A

Syntactic Hierarchy

Level	Target	Example
1	Single word no morphological ending	Single noun
2	Dual word no morphological ending	Noun + Verb Article + Noun Adjective + Noun
3	Single word with morphological ending	Verb + morphological end (ing, ed) Noun + morphological end (s)
4	Dual word with morphological ending on either	Noun & Verb Article & Noun Adjective & Noun
5	Three words or more	Added auxiliary (is, are) Added modal (can, do, would) Adjective + Noun + Verb
6	D-level sentences: 7 levels	1. Infinitival complements with the same subject 2. Sentence with wh-complements 3. Relative clauses modifying object of main verb 4. – ing form as complement (gerund) 5. Relative clause modifying subject of main verb 6. Subordinating conjunctions 7. More than one kind of embedding in a single sentence (Rosenberg & Abbeduto, 1987)

(Adapted from Ball, 2009)

Appendix B

Cue Tracking Tool

Day # ____ Session #_____
Participant:______________________ Clinician being observed:_____________________

Directions: Tally the shaping cues provided by the other clinician. Mark which types of cues were given with a (√). Indicate if the shaping cue resulted in successful verbal communication with a (+) or (–) sign.
Example: √+ or √-

word imitation							
choice of 2 words- dissimilar							
choice of 2 words- similar							
Phonetic (i.e. 1st sound)							
Phonetic with visual hand sign							
Phonetic with visual oral							
Semantic phrase completion							
Semantic function							
Reminder							
Request attention							

Which of the following Participant communicative behaviors were observed?

- Augmentative and Alternative Communication
- Communicative Gestures
- Pointing
- Writing
- Sound effects
- Jargon
- Repeated non-communicative words
- Drawing

(Adapted from Ball, 2009)

Appendix C

Cues coded and corresponding level of power

Type of Shaping Cue	Definition	Example	Cognitive-Linguistic Area/s Stimulated	Level of Power
Request attention	Redirecting the person with aphasia to engage in the language task/game.	Clinician: "Listen, John asked you a question."	Attention	1
Reminder	Reviewing goals or prompting the person with aphasia to recall and use their linguistic goals.	Clinician: "Remember you are working on using the phrase 'do you have' or 'Bob, did you use a verb'?"	Memory	1
Constraint cue	Reminder not to use gestures, writing, drawing, and/or augmentative and alternative communication as a substitution for spoken language.	Clinician: "Try not to use your fingers."	Memory	1
Semantic function	Providing a description of the function of the target word.	Clinician: "This is something you sit on" for the target chair.	Attention, Semantic	2
Semantic reminder	Providing a prompt for more information.	Clinician: "What is she doing in the picture?" or "Can you pair that with a verb?"	Attention, Semantic	2
Semantic phrase completion	Providing a semantically related phrase for the participant to complete using the target word.	Clinician: " People clean their teeth with a ___" for the target toothbrush.	Attention, Semantic, Conceptual Context	3
Phonetic with visual model	Providing a visual model of the articulatory placement of the first phoneme(s).	Clinician: "Look at me it starts with [bites lip and/or points to bottom lip]" for the target /f/ for frog without producing the phoneme	Attention, Phonological, Articulatory motor	3

Phonetic first phoneme(s)	Providing a visual and acoustic model of the first phoneme(s) of the target word.	Clinician: "It starts with /sp/" for the target /spoon/.	Attention, Phonological, Articulatory motor, Acoustic	4
Articulatory placement	Providing a visual, acoustic, and articulatory placement model of the first phoneme(s) of the target word.	Clinician: "Press your lips together." For the target /b/ in blue	Attention, Phonological, Articulatory motor, Acoustic	4
Choice of two words	Presenting the target word along with a semantically or phonemically similar or dissimilar word.	Clinician: "Is it a heart or a cart?" for a phonetically similar cue of the target heart. Clinician: "Is it a cookie or a pizza?" for a semantically similar cue for the target cookie.	Attention, Phonemic, Semantic, Concept, Acoustic, Lexical model	5
Word imitation	Presenting a verbal model of the target word and requesting a repetition	Clinician: "It is a bucket. Say bucket."	Attention, Phonemic, Semantic, Concept, Acoustic, Lexical model	6

Table 1

Clinician Demographic Data

Clinician	Gender	Race	Credentials	Years of Experience	Primary work Setting	% of Practice Dedicated to People with Aphasia
1	Female	Caucasian	CCC-SLP [a]	5.5	Long Term Acute Care	21 - 40
2	Female	Caucasian	CCC-SLP [a]	3.5	Long Term Acute Care	41 - 60
3	Female	Caucasian	CCC-SLP [a]	4	Acute Care Hospital	0 - 20
4	Female	Caucasian	CCC-SLP [a]	5	Acute Care Hospital	21 - 40
5	Female	Caucasian	Student [b]	0	N/A	N/A
6	Female	Caucasian	Student [b]	0	N/A	N/A
7	Female	Caucasian	CCC-SLP [c]	10	University	81 - 100

Note: [a] Master of Arts (MA), [b] Second year Master of Arts student, [c] Doctor of Philosophy, Clinical Certificate of Competence (CCC), Speech Language Pathologist (SLP)

Table 2

Demographic and Linguistic Goal Data of the People with Aphasia

Participant	Gender	Race	Age	Months post onset	Aphasia Type [d]	Motor Speech Disorder	Day 2 Treatment Goals	Day 10 Treatment Goals
Jamie [a]	Female	Caucasian	55	124	Mixed	Mild Apraxia	Use carrier phrase "Do you have ___", nouns	Use complete and interrogative sentences
Rachel [a]	Female	Caucasian	78	48	Anomic	Mild Dysarthria	Use sentences with relative clauses	Use complex sentences with subordinating conjunctions
Mary [a]	Female	African American	69	45	Unable to differentiate	Severe-profound Dysarthria	Word imitation, precise articulation, slow rate	1-2 word phrases, use eye contact and co-players names
Bill [a]	Male	Caucasian	61	137	Anomic	Moderate Dysarthria, Mild Apraxia	Use precise articulation and verbs have and had	Use precise articulation, expand utterances with prepositional phases or repeating targets
Jack [b]	Male	Caucasian	56	41	Broca's	Mild-moderate Apraxia	Use 2-3 word utterances, carrier phrase 'I want __' and adjective + noun	Use 4-5 word utterances, carrier phrases 'Do you have __adjective + noun_?'
Greg [b]	Male	Caucasian	55	73	Conduction	Mild-moderate Dysarthria, Mild Apraxia	Use precise articulation, sentences with modals	Use precise articulation, sentences with relative clauses modifying verbs
Cindy [c]	Female	African American	56	83	Anomic	Mild Dysarthria, Mild Apraxia	Compound sentences with conjunctions, and but or so	Sentences with relative clauses modifying objects
Pam [c]	Female	Caucasian	69	18	Conduction	Mild Apraxia	Use co-players' name, carrier phrase 'Do you have ___?'	Use carrier phrases 'I want __ or I need __ adjective + noun'
George [c]	Male	Caucasian	67	39	Broca's	Moderate-Severe Apraxia	2 word utterances, verbs	3-4 word utterances, carrier phrase 'I want __ adjective + noun or verb'

Note: a = group 1, b = group 2, c = group 3, d = *Western Aphasia Battery-Revised* (WAB-R) *Bedside* (Kertesz, 2006)

Table 3

Raw Number and Percentage of Shaping Cues Provided by the Individual Clinicians: Day 2 and Day 10

Day 2

	Clinicians						
Shaping Cue	1a	2a	2b	3b	4c	5c	Grand Total
Request attention	5 (6)	0 (0)	3 (10)	3 (13)	6 (5)	2 (2)	19 (5)
Reminder	28 (33)	13 (20)	7 (25)	12 (52)	27 (24)	18 (20)	105 (26)
Constraint	9 (11)	4 (6)	1 (3)	0 (0)	1 (1)	2 (2)	17 (4)
Semantic function	1 (1)	0 (0)	2 (8)	2 (9)	5 (4)	2 (2)	12 (3)
Semantic reminder	0 (0)	2 (3)	2 (8)	2 (9)	16 (14)	1 (1)	23 (6)
Semantic phrase completion	11 (13)	9 (14)	2 (8)	0 (0)	8 (7)	15 (17)	45 (11)
Phonetic with visual model	3 (4)	6 (9)	0 (0)	0 (0)	4 (4)	16 (18)	29 (7)
Phonetic first phoneme(s)	1 (1)	16 (24)	10 (35)	3 (13)	14 (12)	10 (11)	54 (13)
Articulatory placement	4 (5)	2 (3)	0 (0)	0 (0)	1 (1)	0 (0)	7 (2)
Choice of two words	12 (14)	9 (14)	0 (0)	0 (0)	18 (16)	0 (0)	39 (10)
Word imitation	10 (12)	5 (7)	1 (3)	1(4)	13 (12)	24 (27)	54 (13)
Clinician Totals	84	66	28	23	113	90	404

Day 10

	Clinicians						
Shaping Cue	1a	1b	2a	2b	6c	7c	Grand Total

Request attention	1 (1)	3 (4)	2 (12)	6 (10)	4 (3)	0 (0)	16 (3)
Reminder	25 (40)	21 (30)	6 (35)	18 (30)	27 (18)	56 (26)	153 (26)
Constraint	0 (0)	4 (6)	0 (0)	3 (5)	1 (1)	0 (0)	8 (1)
Semantic function	0 (0)	1 (1)	0 (0)	0 (0)	6 (4)	4 (2)	11 (2)
Semantic reminder	3 (5)	8 (11)	1 (5)	8 (13)	17 (11)	15 (7)	52 (9)
Semantic phrase completion	2 (3)	7 (10)	0 (0)	6 (10)	21 (14)	26 (12)	62 (11)
Phonetic with visual model	1 (1)	1 (1)	0 (0)	0 (0)	3 (2)	18 (9)	23 (4)
Phonetic first phoneme(s)	3 (5)	20 (29)	3 (18)	19 (32)	24 (15)	46 (21)	115 (20)
Articulatory placement	13 (20)	2 (2)	2 (12)	0 (0)	0 (0)	0 (0)	15 (3)
Choice of two words	10 (16)	2 (2)	0 (0)	0 (0)	14 (9)	15 (7)	41 (7)
Word imitation	6 (9)	3(4)	3 (18)	0 (0)	36 (23)	34 (16)	82 (14)
Clinician Totals	64	70	17	60	153	214	578

Note. Raw data followed by (percent). Percentages were calculated out of the total number of cues each clinician produced on either day 2 or 10. Seven clinicians facilitated three CIAT treatment groups; Clinicians 1 and 2 were present on days 2 and 10 for two different groups. As such, they are listed twice in this table (a = group 1, b = group 2, c = group 3). The remaining clinicians only participated in one group on either day 2 or day 10.

Table 4

Wilcoxon Related Samples Signed Rank Analyses for Number, Power, and Cue Type

	Day 2		Day 10		Wilcoxon Statistics	
	Median	Mean	Median	Mean	*z*	*p*
Number of Cues	75.0	68.0	67.0	96.0	- 1.153	0.249
Power of Cues	21.0	26.6	18.0	28.0	- 0.280	0.779
Cue Type						
Request attention	5.0	5.0	3.0	6.0	- 0.742	0.458
Reminder	24.5	29.0	30.0	29.8	0.717	0.527
Constraint	2.5	3.8	0.5	2.0	- 0.730	0.465
Semantic function	3.0	4.0	0.5	1.2	- 1.289	0.197
Semantic reminder	5.5	5.8	9.0	8.7	- 1.577	0.115
Semantic phrase completion	10.5	9.8	10.0	8.2	- 0.420	0.674
Phonetic with visual model	4.0	5.8	1.0	2.2	- 1.826	0.068
Phonetic first phoneme(s)	12.5	11.8	19.5	9.8	- 1.153	0.249
Articulatory placement	0.5	1.3	1.0	5.7	- 1.069	0.285
Choice of two words	7.0	7.3	4.5	7.8	- 0.184	0.854
Word imitation	9.5	10.8	12.5	11.6	0.000	1.000

Note. Median and mean data are based on the percentage of each cue type provided by the clinicians.

Table 5

Weighted Level of Power by Type of Cues Provided on Days 2 and 10

		Day 2			Day 10		
Cue Type	Assigned Level of Power	Total	Percent of Grand Total	Weighted Level of Power	Total	Percent of Grand Total	Weighted Level of Power
Request attention	1	19	5	5	16	3	3
Reminder	1	105	26	26	153	26	26
Constraint	1	17	4	4	8	1	1
Semantic function	2	12	3	6	11	2	4
Semantic reminder	2	23	6	12	52	9	18
Semantic phrase completion	3	45	11	33	62	11	33
Phonetic with visual model	3	29	7	21	23	4	12
Phonetic first phoneme(s)	4	54	13	52	115	20	80
Articulatory placement	4	7	2	8	15	3	12
Choice of two words	5	39	10	50	41	7	35
Word imitation	6	54	13	78	82	14	84
Grand Total	--	404	--	--	578	--	--

Note. Total was derived by adding each type of cue provided by the clinicians on days 2 and 10. The weighted level of power was calculated by multiplying the assigned level of power by the percent of grand total for each cue type.

CHAPTER 4

Discussion

The overarching goal of this dissertation was to investigate the effect of CIAT on discourse production and the role of shaping during CIAT for people with aphasia. To achieve this goal, two investigations were completed; Study 1: *"Constraint Induced Aphasia Therapy: Examining Linguistic Gains in Discourse*" and Study 2: "*Constraint-Induced Aphasia Therapy: What about Shaping?"*. Both studies were conducted as part of a larger randomized control trial and utilized a repeated measures design. Study 1 revealed that the participants with aphasia exhibited positive linguistic gains on several discourse measures sampled during treatment sessions across the program. No significant differences in the number, type, and power of cues given by trained clinicians were discovered in Study 2. Inspection of the raw data revealed trends that provide insight into how shaping was implemented by the clinicians through cueing that may inform future research. In view of the global purpose, design, and results of this dissertation, overarching themes emerged that may have implications for future CIAT protocols and research; (a) appropriate outcome measures, (b) the presence of motor speech disorders and lastly, (c) the initiation and dosing of CIAT programs. Each theme is discussed below.

CIAT Outcome Measures

Standardized aphasia batteries and quantitative discourse measures. A recent report argued that linguistic outcome measures need to be sensitive enough to capture changes in discourse (Boyle, 2014). Also, they need to display test-retest stability to provide evidence that variations found are indeed the result of treatment and not inconsistencies within the measures themselves. Since, the global aim of CIAT is to enhance communication for people with aphasia by overcoming learned non-use, it is important that outcome measures be functional. It is thought that, “the closer our outcome measures can come to natural discourse, the greater power they will have” (Maul, Conner, Kempler, Radavanski, & Goral, 2014, p. 418). Changes that occur within the controlled structure of CIAT intervention may not be fully reflected in the current post-treatment assessments routinely utilized by researchers and clinicians. Functional discourse measures that are collected during and outside of treatment will aid in determining if the gains made by people with aphasia during CIAT programs consistently generalize to other communicative settings.

Historically, CIAT researchers have relied largely on standardized aphasia assessments such as the *Aachen Aphasia Test* (AAT) (Huber, Poeck, Weniger, & Willmes, 1983), *Boston Diagnostic Aphasia Exam* (Goodglass & Kaplan, 2000) and the *Western Aphasia Battery-Revised* (WAB-R) (Kertesz, 2006) to document linguistic improvements following CIAT programs (e.g., Difrancesco, Pulvermuller, & Mohr, 2012; Faroqi-Shah & Virion, 2009; Johnson et al., 2013; Pulvermuller et al., 2001; Szaflarski et al., 2008). Relatively few CIAT investigations have reported quantitative measures of discourse (e.g., Kirmess & Lind, 2011; Maher et al., 2006; Szaflarski et al., 2008); this fact is problematic as people with aphasia verbally communicate and manifest word-finding difficulties differently during standardized naming tasks and connected speech contexts (Boyle, 2014). Therefore, it is very likely that the pre-post-treatment, standardized aphasia assessment batteries do not fully capture the linguistic gains experienced by people with aphasia following CIAT. Furthermore, if researchers only collect pre-post treatment discourse measures, they run the risk of assuming the treatment generalizes to chosen post-treatment discourse tasks. In other words, the people with aphasia may make important linguistic gains *during* treatment; however, these changes may only be determined by sampling language produced in the treatment. If a discrepancy exists between within treatment and post-treatment discourse analyses, then, perhaps an individualized transfer package could be designed to bolster the generalization of the linguistic gains to other contexts.

Hence, the first investigation of this dissertation intended to examine quantitative discourse measures that may be able to consistently capture improvements manifested in the connected speech of people with aphasia produced over the course of CIAT. More specifically, the purpose of the study was to examine and compare the content, complexity, efficiency, and communicative success of the spoken discourse produced by people with aphasia *during* treatment sessions on days 2 and 10 of a 10-day CIAT program. The proposed measures included: (a) percent of correct information units (CIUs), (b) percent of counted words, (c) type token ratio (TTR), (d) percent mazes, (e) mean length of utterance (MLU), (f) percent of true conversational units (TCunits), (g) CIUs per utterance, and (h) percent of initial successful turns. Several of the measures proved to be sensitive to linguistic changes across the CIAT program. The participants demonstrated significant increases on the measures of percent of CIUs, counted words, TCunits, CIUs per utterance as well as a significant decrease in mazes. No significant increases were demonstrated on the measures of MLU and initial successful turns. Surprisingly, the people with aphasia demonstrated a significant decrease in the TTR (see Study 1 for further discussion). These results were found despite the heterogeneous constitution of the people with aphasia and provide insight into functional discourse measures that may dependably detect linguistic changes. Boyle (2014) reported that the number of CIUs, percent of CIUs, number of T-units (a measure similar to TCunits), and word finding behaviors are sufficiently consistent on test-retest stability measures to be used as reliable outcome measures in group research designs for people with aphasia. Taken together, these findings show that valid functional discourse measures for people with aphasia can be collected during and outside of treatment as well as in a variety of settings. Future research will reveal the sensitivity and practicality of incorporating these outcomes into protocols and may provide insight into how generalization of gains made during treatment is transferred to standardized assessments (e.g., AAT, WAB-R) and other communicative contexts (e.g., conversation, interviews).

The next evolutionary step in selecting the most appropriate functional linguistic outcome measures for CIAT is to compare and contrast the changes detected in the discourse produced by people with aphasia during treatment to discourse produced on pre-post treatment assessments. Evaluation of both standardized comprehensive aphasia assessments and quantitative discourse measures such as those employed in Study 1 should be performed. Clinicians and researchers run the risk of overestimating the generalizability of findings if these comparisons are not made. Some researchers suggest that the WAB-R aphasia quotient (Kertesz, 2006), a standardized aphasia assessment that utilizes a qualitative perceptual ranking scale to evaluate spontaneous speech production, is the most sensitive standardized measure used to capture changes in aphasia type and severity post-treatment (e.g., Faroqi-Shah & Virion, 2009). However, clinicians' ratings on perceptual scales can be influenced by internal and external factors such as training and experience. It is argued that, "even extensive clinical exposure does not exclude clinicians from employing idiosyncratic approaches" (Kelchner et al., 2010) when rating voice production. Certainly, the same can be said of clinicians rating spoken language production. Therefore, perceptual rating scales to evaluate spontaneous speech, such as the WAB-R (Kertesz, 2006) scale, may be vulnerable to inter- and intra-rater reliability error and not as sensitive as formal linguistic analyses when assessing change in discourse production (Grande et al., 2008). Comparing and contrasting documented linguistic changes on pre- post-treatment standardized evaluations and formal quantitative discourse measures (e.g., CIUs, TCunits) collected during the intervention will allow for correlations to be made between the spoken language of people with aphasia before, during, and after CIAT intervention. Even more, collecting discourse data at various time points (i.e., pre-treatment, during treatment, and post-treatment), may inform the development of personalized transfer packages, such as those utilized by CIAT-plus programs (e.g., Meinzer, Djundja, Barthel, Elbert & Rockstroh, 2005) and described by Johnson and colleagues (2013).

Shaping as a possible outcome measure. Study 2 of this dissertation proposed a novel approach to documenting linguistic gains for people with aphasia by comparing the level of communicative support required at the beginning to the end of a CIAT program. To achieve this, the definition of shaping was expanded to include *how* clinicians shape (cue) the targeted syntactical utterances of people with aphasia during CIAT. The purpose of the investigation, "*Constraint-Induced Aphasia Therapy: What about Shaping?"* was to (a) document how linguistic shaping is implemented by trained clinicians through the types of cues provided and (b) investigate changes in the number, type, and power of cues given across a CIAT program. It was hypothesized that changes in the type and power of cues given to people with aphasia by trained clinicians would be an indicative measure of emergent linguistic improvements and communicative independence, over the course of a CIAT program. However, no significant differences in the number, type, and power of cues emerged. It was found though, that the clinicians, as a group, provided the same types of cues (e.g., reminder, semantic phrase completion, choice of two words) at similar rates across the program. Hence, the power of the cues given from day 2 to day 10 of treatment remained constant. It is likely then that the cues types and power remained stable but the linguistic targets of the participants became more challenging. In other words, the clinicians utilized similar cues to elicit differing levels of language. In light of the findings, utilizing differing types and power of cues as an outcome measure to detect higher levels of linguistic competency and independence may not be sensitive enough to reliably reveal changes across treatment programs. Instead, this type of measure is likely only sensitive if data is collected for *each* linguistic goal. For instance, if a person with aphasia has a linguistic goal to include a prepositional phrase while making requests, then a measure of the number and type of cues given to support the addition of a prepositional phrase would be taken at the onset. The baseline number, type, and power of cues would then be compared to the number, type, and power of cues provided when the individual met the goal with a criterion of 90% or higher; it is likely that fewer and less powerful cues will be given.

Ideally, as people with aphasia progress through CIAT programs they will require less communicative support from clinicians, that is the "responsibility for cueing is shifted from the clinician to the patient" (Bandur & Shewan, 2008, p. 777), no matter the linguistic target. This is an important part of preparing individuals for generalization, maintenance, and independence (Doesborg et al., 2004). For this reason, an outcome measure such as self-initiated cues could capture an increase in communicative independence. Self-initiated cues include any type of prompt generated by people with aphasia to assist themselves in word recall, execution or elaboration of information (Griffith, Taylor, Southhard, & Neils-Strunjas, 2013). Constraint-induced aphasia therapy protocols could easily encourage (and develop) self-cueing techniques for people with aphasia by modifying the steps required to create and train personalized cues presented by Marshall & Freed (2006). For instance, before CIAT treatment sessions begin, clinicians and people with aphasia could co-construct cues that the individuals with aphasia use during the sessions when they feel they need assistance. Then the clinicians could first, model the co-constructed cues to elicit targets then provide reminders to use the personalized cues. This method could eventually lead to complete self-initiation of personalized cues and less reliance on clinicians for communicative support. Even more, self-initiated cues are thought to encourage long-lasting communicative independence that may generalize in and out of the treatment setting (Thompkins, Scharp, & Marshall, 2006). The addition of self-cueing methods could be applied to CIAT-plus (Meinzer et al., 2005) programs that utilize transfer packages (e.g., Johnson et al., 2013) to strengthen the generalization of the linguistic gains consistently made by people with aphasia during CIAT (e.g., Kurland, Pulvermuller, Silva, Burke, & Andianoploulos, 2012; Meinzer, Rodriguez, & Gonzalez-Rothi, 2012; Pulvermuller et al., 2001) to other communicative contexts.

Enhancing generalization through transfer packages. An important element allowing people with aphasia to integrate the positive linguistic gains made during CIAT treatment into everyday communication activities is the use of transfer packages (e.g., Johnson et al. 2014, Meinzer et al., 2005). Transfer packages and CIAT-plus programs involve family members and caretakers of people with aphasia to engage individuals in as much communication as possible outside of the clinic setting. These packages often include exercises to be performed independently or with a communication partner, the completion of language worksheets, communication skill assignments at home and in the community as well as communication problem solving for daily tasks (i.e., how to overcome barriers to speaking in specific situations) (Meinzer et al., 2005; Johnson et al., 2013). The specific contribution of these therapeutic exercises completed as part of CIAT outside of the clinic venue to the generalization of linguistic gains is not known, but believed to enhance the functionality of the treatment. Programs that incorporate a range of communication activities needed for full life participation (e.g., phone conversations, story-telling) could shed light on the ability of formal aphasia assessments and discourse measures to capture linguistic changes in home (e.g., watching and discussing sporting games with family and friends) and community environments (e.g., asking questions at the doctor's office). Linguistic gains may generalize more abundantly if transfer packages are individually tailored to address barriers to communication and expand upon the linguistic targets created during CIAT sessions. For example, if a person with aphasia identified participating in a grandchild's basketball game as very important and they had a linguistic goal of incorporating verbs into 2-3 word utterances, then verbs related to basketball would be targeted, appropriate utterances would be practices and self-cues would be co-constructed. So that, the individual would be able to support their grandchild in a more meaningful way in which they expand their cheers from "Go" to "*shoot* the ball" and "*pass* the ball". Additionally, in this manner, a bridge from the impairment to the life participation level (World Health Organization, 2001), could be built to foster communicative independence at all levels and decrease the impact of aphasia on the lives of stroke survivors.

Theoretical framework for positive linguistic gains. People with aphasia may display positive communicative gains after intervention because CIAT is grounded on proven neuroscientific theories. Neuroscience has shown through Hebbian learning that, strong, repeated neuronal stimulation is necessary to develop neuronal associations required for learning (Hebb, 1949). Therefore, the intensive manner in which CIAT is employed may exploit Hebbian learning to strengthen residual neuronal connections and promote synaptic plasticity for language recovery (Pulvermuller & Berthier, 2008) which can be evidenced on appropriate functional outcome measures. Likewise, constraining communication to the verbal modality and requiring people with aphasia to produce higher levels of syntactic complexity may evoke positive linguistic gains for people with aphasia through the use dependent theory. It is thought that one must use a skill, such as spoken language, and practice it repeatedly and correctly to become proficient (Kleim, 2013; Kleim & Jones, 2008). Since the principle of constraint calls for people with aphasia to repeatedly practice high levels of verbal communication with success, they may be recruiting and building the very synaptic connections needed to be competent verbal communicators. Neuronal recruitment has been evidenced in CIAT neuroimaging studies (e.g., Kim, Karunanayaka, Privitera, Holland, & Szaflarski, 2011; Liepert et al., 2000; Meinzer et al., 2004; Taub et al., 1999) and is perhaps why, through intensive successful verbal practice, linguistic gains are demonstrated on both standardized formal assessments and quantitative discourse measures.

Shaping may be equally responsible for the linguistic gains exhibited by people with aphasia after participation in CIAT programs (Meinzer et al., 2012). By creating individualized goals and employing the most effective cueing strategies, shaping is tailored to each person with aphasia who participates in CIAT. The individualized nature of shaping helps create a positive environment in which people with aphasia may feel confident knowing that they are going to receive the support and encouragement they need to successfully communicate. It is thought that learned non-use of spoken communication is established and perpetuated by the negative reinforcement people with aphasia receive when their communicative attempts are unsuccessful (Ball et al., 2006; Taub et al., 2006). The linguistic shaping implemented during CIAT provides many opportunities for people with aphasia to experience successful communication and receive positive reinforcement from clinicians and peers to combat the continuation of learned non-use behavior. The positive reinforcement delivered may motivate people with aphasia to continue speaking and use higher levels of verbal complexity in conversational settings outside of the clinic venue (e.g., Difrancesco et al., 2012; Faroqi-Shah & Virion, 2009; Johnson et al., 2013). In fact, positive reinforcement is a foundational principle of operant conditioning, a well-established psychological method of modifying behavior. Advocates of operant conditioning posit that individuals learn to act and maintain certain behaviors based upon the associations they make with consequences, both positive and negative, they receive from their environment (Skinner, 1938; 1957). Therefore, CIAT may be effective at inducing and maintaining positive linguistic gains because people with aphasia learn to make associations between increased levels of spoken language and the reward of communicative success through the positive reinforcement and communicative support provided by shaping. Unfortunately, to date, the role of shaping during CIAT remains elusive.

Motor Speech Disorders

Aphasia rarely occurs without motor speech impairment (Patterson & Chapey, 2008). Dysarthria, a deficit in motor production which affects the accuracy, coordination, and strength of speech musculature needed to execute intelligible articulation, and apraxia of speech, a deficit in motor planning required for speech execution, are commonly acquired motor speech disorders post-stroke that globally affect speech production (Duffy, 2013). Due to the retrospective nature of this dissertation, a perceptual rating scale needed to be developed to determine the type and severity of any motor speech disorders exhibited by the participants. The rating scale included dysarthria and apraxia of speech ratings utilized by previous researchers (e.g., Bunton, Kent, Duffy, Rosenbek, & Kent, 2007; Haley, Jacks, de Riethal, Abou-Khalil, & Roth, 2012) and allowed naïve clinicians to provide an overall diagnosis and severity level of any detected disorder. While the rating scale showed inter-rater agreement, it does not replace the valuable information that could have been gleaned from a formal oral mechanism examination, an apraxia of speech battery such as the *Apraxia Battery for Adults-Second Edition* (ABA-2) (Dabul, 2000) or a standardized measure of speech intelligibility, *Assessment of Intelligibility of Dysarthric Speech* (Yorkston & Beukelman, 1981).

All of the participants demonstrated a concomitant motor speech disorder; three exhibited dysarthria and apraxia of speech, one severe-profound dysarthria, another moderate-severe apraxia of speech, and the remaining displayed mild-moderate dysarthria or apraxia of speech (see Study 1 Table 1 p. 69 for more details). Motor speech disorders most likely adversely affected the ability to detect individual changes in spoken language production; especially for those that presented with more than a moderate dysarthria or apraxia of speech. In fact, the individual (i.e., Participant 3, Study 1) who presented with severe-profound dysarthria had extremely limited speech intelligibility, which rendered discourse analysis impossible. The person with moderate-severe apraxia of speech (i.e., Participant 9, Study 1) did not display such restricted speech intelligibility, instead their primary difficulty was in speech planning and execution at the one- and two-word level. Because of the motor speech disorders presented by the participants, it is difficult to determine what percentage of the CIAT program was dedicated to improving the syntactic complexity of the participants' utterances versus increasing the participants' intelligibility and speech execution. Anecdotally, the clinicians who facilitated the program were observed spending a considerable amount of time devoted to speech planning, execution, and intelligibility goals, which does not completely align with the global aim of CIAT as an exclusive language intervention. Since, aphasia rarely occurs without motor speech involvement (Patterson & Chapey, 2008), many people with aphasia require intervention for both language and speech planning/execution (Wambaugh, Wright, Nessler, & Mauszycki, 2014) and treatments that target both are warranted. Therefore, it is imperative that motor speech deficits be addressed in CIAT programs not just linguistic deficits.

The influence of motor speech disorders became very apparent in the analysis of study 2. It could not be determined whether the people with aphasia demonstrated linguistic gains through a decrease in the number of word-level cues given over the course of the CIAT program because word-level cues (i.e., word imitation, choice of two words) were also used as speech production prompts. Perhaps CIAT could account for the motor speech disorders commonly associated with aphasia by establishing separate individualized syntactic, speech planning/execution, and intelligibility goals. Then the individual goals could be discussed in combination with the linguistic outcomes exhibited by people with aphasia to shed light on the influence CIAT has on both the linguistic communication and speech production of people with aphasia. It is plausible that speech planning/execution goals strongly influence the linguistic outcome measures. Common therapeutic strategies employed by people with dysarthria to increase verbal intelligibility may include breath group patterning, optimizing phrase length, and utilizing simple short utterances (Yorkston, Beukelman, Strand & Hakel, 2010). These strategies while they are effective at increasing an individuals' verbal intelligibility, may negatively impact language complexity. For example in Study 1, Participant 2 exhibited a large decrease in her MLU. However, she had an individualized speech production goal to increase her intelligibility and she likely traded a shortened MLU for an increased level of intelligibility. For this reason, it is important that language and speech planning/execution goals and gains be discussed together, as one individual may make a positive improvement on a speech planning/execution goal that appears as a negative (but necessary) result in light of a linguistic goal.

Joint language and motor speech intervention. The *Combined Aphasia and Apraxia of Speech Treatmen*t (CAAST) (Wambaugh et al., 2014) intervention program presents a framework for combining linguistic and speech execution intervention in one setting. Wambaugh and colleagues (2014) combined the cueing strategies utilized in *Modified-Response Elaboration Therapy* (e.g., Wambaugh, Wright, & Nessler, 2012) with the cueing strategies implemented during *Sound Production Treatment* (e.g., Wambaugh & Mauszycki, 2010). During the treatment clinicians provide reinforcement, modeling, and forward chaining cues to increase the language complexity of people with aphasia and give modeling, repetition, minimal pair contrast, integral stimulation, articulatory placement and feedback cues to improve the articulation of targeted speech sounds for those with concomitant apraxia of speech. The researchers found that all of the participants displayed increases in production of content and only one of the four showed improvement on a single word speech intelligibility test. They speculated that the CAAST treatment did not allow for frequent enough practice of specific speech sounds during the approximately 20 hours of intervention for significant improvements in speech production to be evidenced. Principles of motor learning suggest that speakers need numerous opportunities to correctly practice movements for targeted speech sounds and utterances in order for rehabilitation to occur (Yorkston et al., 2010), which may have contributed to the results.

The cues utilized by CAAST are very similar to the types of cues implemented during CIAT (see Study 2 pp. 116-117 for specific cue types). Perhaps the intensive and individualized nature of CIAT can provide the amount of repeated successful practice of targeted erroneous speech sounds required by efficacious apraxia of speech treatments (e.g., Wambaugh, Nessler, Cameron, & Mauszycki, 2013; Yorkston et al., 2010). To date, it is unknown whether the cues provided during CIAT for speech planning/execution simultaneously improve linguistic function. If standardized assessments of apraxia of speech and intelligibility are employed by future investigations, then this knowledge may come to light. Theoretically, the same domains of language knowledge are stimulated by cues used to prompt *both* language and speech planning/execution (e.g., modeling, repetition, choice of two words). Proponents of the spreading activation theory (Dell, 1986) and parallel distributed processing model for language comprehension and production (Kendall et al., 2008; Nadeau, 2001) suggest that comprehension and production of language can be envisioned as a web of connections between areas of language knowledge; phonologic, semantic, conceptual, visual, and articulatory-motor. The pattern of knowledge activation among language domains and the stimulation strength of cues provide, *no matter the cue type*, determines which words are understood, retrieved, motor planned, and articulated (Dell, 1986; Kendall et al., 2008; Nadeau, Gonzalez-Rothi & Rosenbeck, 2008; Nadaeu, 2001). Therefore, perhaps CIAT clinicians and researchers should consider establishing CIAT goals and outcome measures for both language complexity and speech production as the same cue types may be able to elicit positive changes in both linguistic skills. It is the author's opinion that a new conceptualization of CIAT is evolving; one that does not view language and speech production intervention as mutually exclusive but rather holistically as *post-stroke communication rehabilitation* that simultaneously promotes skills which are necessary for survivors to become functional independent communicators.

Initiation and Dosing of Treatment

Recently, researchers observed that stroke survivors with acquired aphasia in the acute phase of their recovery engaged in significantly less communication activity than other stroke survivors without aphasia. They propose that the decreased social interactions evidenced by people with aphasia early in recovery prompt "learned communicative non-use" (Godecke, Armstrong, Hersh, & Bernhardt, 2013, p. 3). Then, it stands to reason that learn non-use of spoken communication coincides with the onset of aphasia. Therefore, early interventions are warranted. In fact, stroke literature suggests that stronger outcomes occur when intensive treatments are initiated early in the recovery process. Perhaps there are windows of time during which treatment maybe particularly effective in inducing neuroplasticity for recovery (e.g., Kleim & Jones, 2008; Kirmess & Maher, 2010; Robey, 1998). Clearly more early intervention research is sorely needed, especially since there is a paradox in the field of aphasiology. Most aphasia research, including this dissertation, is performed with individuals who are in the chronic phases of recovery (i.e., more than one-year post-onset). This fact makes it difficult to apply the methods and results, to the majority of rehabilitation people with aphasia receive in the acute phase (i.e. less than one-year post onset) (Linebaugh, Baron, & Corcoran, 1998). Therefore, forthcoming investigations need to question if CIAT is equally efficacious for individuals in all stages of aphasia recovery, acute through chronic to determine ideal candidates. Kirmess and Maher (2010) explored the applicability and effectiveness of a CIAT program modified for individuals in the acute phase of recovery. Due to fatigue, the investigators found the principle of intensity challenging to apply in the inpatient rehabilitation hospital setting; nevertheless each participant demonstrated linguistic gains. Most importantly, no obvious negative factors of the intervention became apparent. This finding supports the use of a modified CIAT program in early recovery and proposes that individuals with acute aphasia are appropriate candidates. However, it is still unknown who benefits most from CIAT and how time post onset and individual stamina influences outcomes.

The fatigue of the participants with aphasia is thought to have affected the results of both studies in this dissertation. Many of the people with aphasia were observed commenting that they were tired on day 10 of the program. In fact, one of the participants in Study 1, with concomitant severe-profound dysarthria (i.e., Participant 3), became so exhausted over the course of the program that her speech was nearly unintelligible on the last day of the treatment and discourse analysis could not be performed. Therefore, the full impact of the CIAT program on her language recovery is undetermined. Possibly with increased stamina, or a modified CIAT program that was slightly less intense, she would not have experienced such degradation in her speech. Also, the number of cues and level of support the people with aphasia required at the end of the 30 hours of treatment may have increased because of fatigue and affected the results of Study 2. It is not uncommon for people with aphasia to become exhausted by intensive treatments (e.g., Rodriguez et al., 2013). While intensity is a proven effective element to aphasia interventions, including CIAT (e.g., Bhogal, Teasell, & Speechley, 2003; Cherney, Patterson, Raymer, Frymark, & Schooling, 2010), the specific intensity or dosing that causes the most change has not been identified. Certainly, fatigue and setting limitations such as inpatient rehabilitation centers (Kirmess & Maher, 2010) do not always render intensive treatment schedules feasible (or fitting) for all individuals and programs that modify the intensity of CIAT should to be explored (Sickert, Anders, Munte, & Sailer, 2014).

There is evidence to support that people with aphasia make positive linguistic gains with less intense programs. However, it is necessary to clearly define intense treatment. A recent investigation described intense treatment as including three manners of implementation;

> (a) a greater number of therapeutic events in a shorter amount of time; (b) a greater number of hours spent in therapy in a shorter amount of time (massed practice), as opposed to fewer hours of therapy in a longer total amount of time (distributed practice); or (c) a greater number of total hours spent in therapy (Harnish et al., 2014, S286).

Szaflarski et al. (2008) in a pilot study applied the massed practice principle to a one-week CIAT protocol and found that all three participants with chronic aphasia demonstrated improvements on formal language testing and two individuals made substantial improvements on measures of comprehension and verbal production. On the other hand Sickert and colleagues (2014) modified a CIAT program to allow people with acute aphasia (i.e., 1-4 months post onset) to receive two hours of treatment over 15 days. The researchers found that a group of 50 people with aphasia exhibited significant improvements on all sub-tests of the AAT (Huber et al., 1983). Even more, the participants did not report feeling overwhelmed by the treatment schedule. Therefore, modified CIAT protocols that apply intensity in differing manners for individuals with chronic and acute aphasia are proving to be feasible and therapeutically effective (Kirmess & Maher, 2010; Sickert, et al., 2014; Szaflarski et al., 2008). Still, more knowledge is needed to manage fatigue and the dosing of intensity to optimize recovery. As a follow up to this dissertation, the discourse and shaping analyses utilized should be extended to individuals in the acute phases of recovery, conceivably in a modified manner to shine light on candidacy and outcomes of CIAT based on time post onset and dosing. Perhaps, when CIAT is well-timed, the intervention can harness and positively direct spontaneous recovery (Linebaugh et al., 1998) to optimize the amelioration of linguistic deficits.

Limitations

Due to the retrospective nature of this dissertation, unavoidable limitations arose that may have restricted the interpretation and application of the results. Since the initiation of the larger NIH project, "*fMRI of Language Recovery Following Stroke in Adults*" (NIH R01 NS048281), the use of full aphasia assessment batteries for pre-post treatment measures such as the AAT (Huber et al., 1993) or WAB-R (Kertesz, 2006) have emerged as standard practice for CIAT researchers (e.g., Johnson et al., 2013; Kempler & Gorrall, 2011; Meinzer et al., 2012; Sickert et al., 2014). This investigation utilized the WAB-R bedside (Kertesz, 2006), a screening tool to help classify aphasia type, only prior to the onset of treatment; subsequently this dissertation reports the baseline aphasia type and severity for the participants. Therefore, the extent to which these projects can be compared to other CIAT investigations that present full aphasia assessments is limited. Similarly, the addition of a pre-post treatment, standardized apraxia of speech assessment such as the ABA-2 (Dabul, 2000) utilized by previous researchers (e.g., Kurland et al., 2012) would have enhanced these investigations by highlighting the potentially positive impact of CIAT on motor speech disorders. However, without assessment, the effect of CIAT on the speech production of the people with aphasia is unknown. Also, analyses were conducted from day 2 and day 10 of treatment without pre- post-treatment comparison; therefore, the findings may be over- or under-estimated. Another highly plausible limitation during the analyses of this dissertation is that treatment fidelity checks were not performed during the CIAT program. Even though the clinicians received the same intensive training, characteristics of the clinicians' (e.g., level of experience) appeared to influence how they facilitated the CIAT treatment, especially in regards to the shaping employed (Study 2). It was not possible to control for the individual clinician characteristics during this project, but future research designs that integrate treatment fidelity checks will illuminate how closely clinicians adhere to the treatment protocols and improve their internal validity (Hinckley & Douglas, 2013).

Conclusion

People with acquired aphasia strive to return to their pre-stoke lives, where they could easily communicate in a variety of activities (Worrall et al., 2011). This dissertation provided evidence to endorse the efficacy of CIAT to ameliorate post-stroke communication deficits. A framework was presented to explore the use of discourse analysis as a possible outcome measure that can be employed before, during, and after treatment as well as applied to transfer packages. Also a manner to investigate the effect shaping may have on the outcomes people with aphasia experience after CIAT was proposed. This dissertation project may inform the development of future CIAT protocols to further enhance functional verbal discourse for people with aphasia. Researchers are still determining the most appropriate outcome measures that highlight how constraining verbal language to specific syntactic hierarchies and shaping through cueing bolsters language recovery. To a further extent, how CIAT simultaneously strengthens linguistic and speech production is unknown. Also, it yet to be determined when people with aphasia benefit most from CIAT in the acute or chronic stages and with what level of intensity. Despite the paucities of CIAT research, this dissertation adds to the growing body of evidence that consistently reports positive outcomes for people with aphasia (e.g., Meinzer et al., 2012). CIAT may be on the cusp of evolving into a holistic post-stroke communication intervention program that concurrently promotes necessary skills for stroke survivors to once again become independent communicators.

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