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Improving the Speech Intelligibility of Adults with Down Syndrome (DS) using the Core Vocabulary Approach

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Improving the Speech Intelligibility of Adults with Down Syndrome (DS) using the Core Vocabulary Approach

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Dedication

This thesis is dedicated to my loving parents, Mike and Josie Easter who have pledged their life to support and enhance my own. Without each of you, I would not be the person I am today and the person I strive to become. Thank you for telling me what I'm capable of and for providing me the unconditional love and guidance I needed to create a dream to chase after. You both have instilled perseverance within me and have never stopped believing that I have the strength to reach any of my goals.

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Abstract

Improving the Speech Intelligibility of Adults with Down Syndrome (DS) using the Core Vocabulary Approach

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Abstract: The goal of the present study was to evaluate the efficacy of the Core Vocabulary approach (CVA; Dodd, Holm, Crosbie, & McIntosh, 2006) for improving speech intelligibility in an adult with DS by establishing consistent word production in order to enhance communicative competence and participation within a variety of social settings. Research indicates marked limitations in speech intelligibility in individuals with DS, including delayed and disordered articulation and inconsistent speech errors (i.e., variability in production of the same word) that continues throughout the individual's life (Kent & Vorperian, 2013). This study evaluated the effectiveness of CVA on intelligibility by targeting reduction in variability in target word productions selected because they were functionally salient for the client. Data collection consisted of a slight adaptation to CVA, including both speech accuracy and variability measures to evaluate the effect of CVA. The following question was addressed: What are the effects of core vocabulary on the variability and accuracy of production of target words in an

adult with DS? Results suggest that vowel accuracy is a relative strength in her system as compared to consonants, and two-syllable shaped words are her upper boundary. However, while accuracy measures demonstrated some slight improvement across intervention sessions, variability remained stable and did not show the same change over time. A variety of adaptations and possible future research topics are discussed.

Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction

Overall speech intelligibility in individuals with Down Syndrome (DS) is diminished by several factors including their oral anatomical structures and function, impaired motor control and coordination between articulators (Kumin, 2002). In addition, behavioral correlates of these anatomical and functional differences result in phonological delays and possible features of speech disorder (Cleland, Wood, Hardcastle, Wishart & Timmins, 2009). However, some researchers suggest that individuals with DS actually present with a phonological disorder as compared to a delay (Dodd & Thompson, 2001). Furthermore, individuals with DS frequently present with articulatory and phonological patterns that demonstrate inconsistent errors and inconsistent production and variability of the same word, which continue throughout their lifetimes (Kent & Vorperian, 2013). Such findings are vital to take into account when considering effective interventions to improve speech intelligibility. Accordingly, the goal of this project is to evaluate a potential intervention approach for its efficacy with a young adult with DS.

There are a variety of language intervention suggestions for DS within present research, including the use of augmentative communication devices (e.g., Iacono & Duncum, 1995; Sigafoos, Green, Payne, Son, O'Reilly, & Lancioni, 2009) picture-based communication aids and books (e.g., Trudeau, Cleave, & Woelk, 2003), and other communication outlets that do not necessitate the requirement of speech in order to

communicate. However, speech intelligibility interventions for DS, especially empirically-based interventions are scarce (Martin, Klusek, Estigarribia, & Roberts, 2009). A hypothesis regarding the lack of speech interventions would be that speech is much more difficult for individuals with DS to acquire as "it is the most neurologically and physiologically complex of the communication systems" and requires coordination of articulators, strength and precise muscle movement timing, in addition to a variety of prerequisites, such as respiratory and oral motor abilities (Kumin, 2002, p. 396).

When selecting an appropriate speech intervention for a given client, there are many factors speech-language pathologists (SLPs) should be mindful of. Such aspects include selection of the unit to be targeted (e.g., individual sound, whole word, etc.), target selection (e.g., target sounds for intervention), the type of delivery, the structure of intervention, etc. (Crosbie, Holm & Dodd, 2005). In addition to these variables, SLPs should prioritize targets that address family concerns and priorities, and consider severity of the individual's deficit and the functionality of the target within other settings (Martin, Klusek, Estigarribia, & Roberts, 2009). Moreover, when working with an individual with DS and deciding on appropriate intervention, it is imperative to consider the cognitive-behavioral phenotype, cognitive level, and developmental path (Martin, Klusek, Estigarribia & Roberts, 2009).

Concerning selection of intervention targets, current research on intervention for speech disorders highlights a variety of ways in which to select targets for clients. Some variables include targeting either early or later-developing speech sounds, the targeting of

stimulable sounds, and examining targets based on consistent vs. inconsistent speech errors (Gierut, Morrisette, Hughes & Rowland, 1996). For instance, some researchers have suggested that targeting later-developing speech sounds can result in more speech improvement overall as compared to early-developing sounds (Gierut, Morrisette, Hughes & Rowland, 1996).

However, Rvachew and Nowak (2001) suggest that children with more moderate to severe speech delay exhibit greater generalization to early-developing sounds as compared to later-developing sounds. The investigators conducted a two-group design in which 48 preschool-aged children (mean age between 49 and 51 months) presenting with moderate to severe delays in phonological ability received treatment for four phonemes. Participants were separated into two different groups, targeting either early-developing phonemes for which they had the most productive phonological knowledge or later-developing phonemes for which they had the least productive phonological knowledge. Intervention procedures consisted of 12 weekly sessions split by a treatment block.

Phoneme targets were selected on the basis of assessment results relating to speech sound production within words (manner and placement). An additional assessment included collection of speech samples to calculate Percentage of Consonants Correct (PCC; Shriberg & Kwiatkowski, 1982) an accuracy measure of consonant productions. During treatment, each participant practiced the production of ten words for each targeted phoneme. Picture cards representing such words were presented to elicit such productions in which the targeted phoneme was within the initial position. Furthermore, procedures

consisted of seven steps including imitation of syllables and then words, spontaneous production of words, and later spontaneous sentences. Investigators reported that individuals targeting early-developing phonemes demonstrated more success in acquisition of target phonemes during therapy sessions and showed spontaneous production of more complex phonemes as compared with the other group. Therefore, the researchers suggest it may not be necessary to teach late-developing speech sounds to attain spontaneous production of other late-developing speech sounds.

A different perspective on target selection, however, is the use of functional whole-words that are produced inconsistently (inconsistent error types), rather than isolated speech sounds as targets of intervention. The Core Vocabulary Approach (CVA, Dodd, Holm, Crosbie, & McIntosh, 2010) emphasizes the importance of using functional words that are used frequently by the individual and focuses on mastering consistency, rather than accuracy of such words. Targeting whole words, at least initially, has shown promise with individuals presenting with DS (Dodd & Thompson, 2001) and is described in more detail later within the paper.

Regarding how to work on selected speech and/or phonological targets during intervention, the SLP is presented with more choices. Many phonological interventions have been developed for individuals with speech disorders. Some phonological approaches include minimal pairs (Cooper, 1968) and maximal oppositions (Gierut, 1990). Minimal pairs (Cooper, 1968) works to improve speech production by contrasting the client's error with that of the target sound by using minimal pairs of words, which

only differ by one sound (e.g., f/p; fan—pan, fig—pig, etc.). The maximal oppositions (Gierut, 1990) method, however, contrasts the target sound with a sound that the client can already produce correctly rather than the client's error.

Dodd and Bradford (2000) contrasted the effect of phonological contrast therapy, CVA (Dodd, Holm, Crosbie, & McIntosh, 2010) and Prompts for Restructuring Oral Muscular Phonetic Targets (PROMPT; Hayden, 1999) for children with either inconsistent or consistent speech disorder patterns. Investigators conducted a multiple baseline design with alternating interventions consisting of the three therapy methods. Three male boys between the ages of three and five years who presented with phonological impairment participated within the stud. They attended bi-weekly 30-minute sessions over a span of six weeks. Within the phonological contrast therapy trial, one phonological process was selected and targeted for each participant based on prior analysis of collected speech samples= During the CVA trial, consistency of word production, rather than accuracy, was targeted. Functional words were selected and taught to the participants through a variety of methods, such as sound and syllable segmentation, and imitation. When the consistency criterion was met (90% consistency), targeted words were integrated into phrases, and new single word targets were selected. Next, the PROMPT trial focused on features of motor control and programming, and reshaping articulation of phonemes using a variety of tactile cues. Phoneme targets were selected according to the participants' stimulability and normal acquisition milestones. The trial entailed practice of phonemes in isolation followed by words and phrases.

Following the three therapy trials, findings revealed that the participants presenting with inconsistent speech disorder gained most improvement from CVA, which targeted whole-word consistency (consistency, rather than accuracy of the same word production). However, the one participant presenting with consistent speech disorder gained more improvement from phonologically- based intervention (i.e.. phonological contrast therapy)

It is important to consider the cognitive-behavioral phenotype of individuals with DS and how they typically present with phonological patterns that include inconsistent errors and inconsistent production of the same word (Kent & Vorperian, 2013). Research on speech interventions for DS are generally scarce (Martin, Klusek, Estigarribia, & Roberts, 2009), but given the evidence in support of CVA for children presenting with inconsistent speech disorder (Dodd & Bradford, 2000) it is very possible that these improvements could be achieved in individuals with DS. The present study reports on the use of CVA (Dodd, Holm, Crosbie, & McIntosh, 2006) to evaluate the potential benefit it may have on the speech production of a young adult with DS. CVA focuses on improving consistency of speech production of same words and has demonstrated relative benefit for individuals presenting with inconsistent speech production patterns.

REVIEW OF CURRENT SPEECH TREATMENTS FOR DOWN SYNDROME

Current speech interventions that have demonstrated to be at least somewhat beneficial for individuals with DS include Phonological Awareness Training (PAT; van

Bysterveldt, Gillon, & Foster-Cohen, 2010) and Core Vocabulary Approach (CVA; Dodd, Holm, Crosbie, & McIntosh, 2010) as they target underlying deficits in such individuals. PAT requires the client to be mindful of speech sound structures and is usually evaluated by the client making judgments about words and sounds presented orally (real words and/or non-words). Structures of words are selected that pertain to specific speech targets the client is working on. PAT covers a variety of skills, including segmenting an utterance into words, awareness of individual phonemes within words, and identification, detection, contrasting or blending of words, sounds and syllables (Williams, McLeod, & McCauley, 2010).

CVA (Dodd, Holm, Crosbie, & McIntosh, 2010) targets consistency in production of the same functional words across trials, rather than accuracy, in individuals with inconsistent speech sound disorders (SSDs). Such individuals with inconsistent SSDs tend to produce different types of errors (e.g., phoneme variation) (Dodd, Holm, Crosbie, & McIntosh, 2010). More information regarding CVA will be presented within the next section.

Kennedy & Flynn (2003) conducted a phonological awareness-based (PAT) intervention modified from Gillon (2000) to investigate whether PAT-based intervention could improve speech production in children with DS. The researchers employed a multiple baseline study, involving three children with DS between the ages of 7; 2 and 8;10 years. The intervention procedure consisted of 8 1-hour sessions conducted bi-weekly and focused on a variety of pre-literacy skills. Skills included phoneme isolation,

spelling of “regular words”, and alliteration detection, in which the participants practiced awareness of single phonemes within tasks. Within spelling of “regular words”, the participants were asked to cross out one of three words that did not rhyme with the others. The investigator then verbally presented a third rhyming word and asked participants to write it down and then together practiced onset phonemes to a variety of rimes to emphasize phoneme awareness and rhyming. Within tasks focusing on alliteration detection, initial phoneme segmentation at both the onset and rime level were practiced. For instance, investigators presented an array of six pictures and asked participants to select the correct picture that started with a specific phoneme. Other rhyming tasks were also presented and consisted of targeting the participants’ attention to the orthographic and phonological similarities within words that rhymed. Illustrations of such words were also used to supplement the written forms. The investigators noted the percent correctness within each task for each participant and it was predicted phonological awareness therapy would result in improved grapheme-phoneme abilities in the participants and thus result in enhanced speech production.

The researchers discovered that the PAT-based approach resulted in improved ability on phonemic level tasks only targeted within sessions, but did not generalize to untrained tasks (e.g., phoneme segmentation task). Nevertheless, while minimal, the researchers reported improved Percentage of Consonants Correct (PCC; Shriberg & Kwiatkowski, 1982), an accuracy measure of consonant productions. This was particularly demonstrated in the increased accurate production of stops, fricatives and

affricates. While Kennedy & Flynn (2003) suggest the PAT- based intervention can help to improve the production of certain consonants (e.g., fricatives and stops), it was noted that the targeted concepts within the intervention required a certain level of metalinguistic and phonological awareness ability that are generally challenging for individuals with DS. Individuals this particular approach may demonstrate more benefit as it may require a higher level of cognitive ability and stronger receptive language skills.

Van Bysterveldt, Gillon, and Foster-Cohen (2010) also conducted an integrated speech and phonological awareness intervention study with ten preschool-aged children between the ages of 4;4 and 5;5 years with DS. The multiple single-subject design integrated speech, letter knowledge and phonological awareness tasks that focused on each child's particular speech targets, along with a parent-implemented home program focusing on print referencing, and the collection of pre and post-treatment measures. Letter knowledge and phonological awareness measurements consisted of letter name and sound knowledge tasks, in which the participants were required to point to specific letter names or sounds the investigator asked (e.g., "Which one says ___?" or "Show me the letter ___."). Initial phoneme identity tasks (Gillion, 2005) were also administered, which focused on having the participants attend to the initial sound in a word and required the participants to identify the same initial sound within an array of three words. Initial phoneme identification within words (Gillion & McNeil, 2007) was also conducted and focused on attending to the sound of a letter and then having the participants identify the letter as the first sound within a word.

The investigators measured the correct production of target sounds, percentage of consonants correct, PCC; Shriberg & Kwiatkowski, 1982) and percentage of vowels correct (PVC; Shriberg & Kwiatkowski, 1982) all of which, although with much variability, improved following intervention. Results demonstrated phonological awareness tasks could be successful in improving speech errors at the single-word level in children with DS. While post-treatment results revealed a greater increase in correctness in targeted words as compared with control words, it was notable that speech production improved in accuracy on both single trained and untrained words. However, such improvement did not generalize to untrained phonological awareness tasks (e.g., identification of initial sounds). Researchers noted that children who presented with developmental language ages of at least three years exhibited the greatest speech improvements. While phonological awareness approaches hold some promise for slight improvement in speech production, it does require a level of cognitive ability and meta-awareness skills, including the ability to reflect on one's speech and structure of words (Williams, McLeod, & McCauley, 2010). CVA aims to improve an individual's production of whole-word consistency as it targets inconsistency errors that are characteristic for individuals with DS, and therefore may more appropriately target the underlying deficits in those with DS.

CORE VOCABULARY APPROACH

While there are currently many approaches focused on intervention for SSDs (See Williams, McLeod & McCauley, 2010 for a review), such effective interventions are not well explored relative to adaptations for DS (Van Bysterveldt, Gillon, and Foster-Cohen, 2010). The present study utilizes the Core Vocabulary approach (CVA; Dodd, Holm, Crosbie, & McIntosh, 2010), as it has been demonstrated to be effective in improving the consistency of speech production in individuals who present with persisting variability in production output, a speech pattern that is characteristic in the speech of DS individuals. Furthermore, many researchers speculate that an underlying deficit in the speech production of individuals with DS is impairment in phonological pre-motor planning. The key feature of this deficit is difficulty in sequencing the appropriate sounds that produce a given word, and results in unpredictable inconsistency in production of the same word (Cleland, Wood, Hardcastle, Wishart & Timmins, 2009; Dodd, Holm, Crosbie & McIntosh, 2010).

The selection of targets for an intervention approach may be challenging as an individual with inconsistent speech disorder may produce a variety of speech sound substitutions. Thee substitutions may differ in manner and place of production across different tokens of a word type, thus increasing variability in output patterns. Moreover, the individual may also omit or include additional sounds. CVA targets inconsistency in speech production within words and does not focus on specific sound aspects or surface error patterns. Rather, CVA focuses on production of whole-words or short phrases that

are deemed functional and used frequently by the client. This aspect of CVA is especially salient for the cognitive capacities of individuals with DS relative to overall intelligibility. Functional approaches to intervention need to be incorporated throughout therapy, as generalization may be difficult. CVA targets consistency of word production, and therefore targets the fundamental issue in phonological planning (Crosbie, Holm, Dodd, 2005).

Dodd and colleagues suggest individual, twice-weekly sessions, 30-minutes in duration (e.g., Dodd, Holm, Crosbie, & McIntosh, 2010). The clinician, client and client's parent/ guardian construct a master list of approximately 70 frequently used target words deemed functional for the client. The first general goal of CVA is, "for the child to achieve an appropriate productive realization of each target based on the child's phonological system and phonetic inventory" (Dodd, Holm, Crosbie & McIntosh, 2010, p. 129). Therefore, during the initial session of each week, 10 target words are randomly selected from the master list and are taught via drilling sound-by-sound to elicit the most accurate and consistent production of each word. Following drill, the clinician integrates target words into activities to be practiced for the remainder of each initial session. Parent/ guardian support is also expected. A family member reinforces the client's use of the core vocabulary and participates in practicing with the client at home.

The second session each week focuses on reviewing the same 10 target words. Subsequently, the client is assessed on his/her production of each target word, by producing each word three consecutive times. Words that are produced consistently three

times each (regardless of accuracy) are considered mastered. They are then omitted from the list of words to be practiced. However, words that are not consistently produced are considered not mastered and continue to be practiced. Another general goal of CVA is for the client to consistently use an established best production, and therefore, untrained words are elicited three times each to assess generalization of speech production every 14 days. The overall goal is for the client to enhance his/her speech intelligibility by improving the consistency of word production.

Dodd and Thompson (2001) investigated the difference between speech error patterns in children between the ages of 5; 5 and 15;10 years with DS and patterns in non-DS children who were intellectually average but presented with phonological disorders whose errors were considered inconsistent. Investigators found that the two groups did not differ in the number of whole words produced inconsistently. They did differ in the quality of inconsistent errors. The non-DS group produced more changes to phonemes and used a larger array of substitutions than the DS group. Based on their results, the investigators suggest to initially target consistency of word production for individuals with DS.

EVIDENCE-BASED PRACTICE

Evidence-based practice (EBP) is a valuable framework that allows SLPs to identify the best clinical evidence of an intervention approach for a given client in order to provide more effective therapy (Dollaghan, 2004). Part of ethical planning requires the

understanding of the EBP level of available research on a given intervention with a specific population of individuals with SSDs. Evaluating the EBP level of available research enables clinicians to identify the most appropriate treatment intervention/s for a client based on research. As a clinician, it is important to also consider the SLP's clinical experience, the family's culture and beliefs, and the client's needs as all such factors are also significant aspects of the EBP framework that help to make an informed intervention decision (Paul & Norbury, 2012). Schlosser (2003) stated that using EBP will facilitate improvement within clinical services, help connect the gap between research and real-world practice, in addition to making SLPs responsible for their clinical decisions and help to decrease overall variation within service delivery, which may in turn, enhance clinical services.

Dollaghan (2004, 2007) suggested standards clinicians should be mindful of when considering the scientific evidence of a given intervention. Such principles include: 1) Clinician should view the opinions of expert authorities with caution, 2.) Not all research is created equally, and thus just because an article gets published, doesn't necessarily mean it's true. Furthermore, some studies are "better" in regard to advising clinical decisions, and 3.) SLPs need to be critical about the quality and level of EBP when using it to inform decision-making. As result, the stronger the level of evidence an SLP uncovers for a given intervention, the more self-assured s/he can be about the clinical efficacy as it's supported by scientific evidence.

Dollaghan (2007), Fey and Justice (2007), and Sackett et al. (2000) constructed a consistent way for any clinician to create a clinical question, and thus, to incorporate EBP into his/her practice. The acronym, "PICO" helps clinicians to formulate appropriate clinical questions and stands for: (P)- patient or problem, (I)- intervention being considered by clinician, (C)- other treatment as comparison treatment, and (O)-desired outcome. In using this EBP construct, the clinician can assemble internal evidence (e.g., family's preferences). Examining the internal evidence relates to speaking with the client and his/her family to become better acquainted with their preferences and needs. Fey and Justice (2007) strongly recommend for SLPs to investigate the client's and family's willingness to participate within the selected treatment approach, consider their preferences and concerns, and evaluate one's own preferences as a clinician, in addition to professional competencies, and values and culture of both the clinician and that of the client the SLP will work with. The next step is to gather external evidence and then rate the studies according to their level of evidence and relevancy to the clinical question to better answer the PICO question.

Once the clinician acquires the necessary research, the evidence must be evaluated. Fey and Justice (2007) have outlined a hierarchy ranked by levels of evidence, according to the type of study conducted and evidence provided. The hierarchy consists of seven levels extending from the highest and strongest level (Ia), down to V, the lowest, weakest level. For instance, a "systematic meta-analysis of multiple well-designed randomized controlled studies" is considered the highest level of evidence (level Ia) in

which the study systematically and statistically merges pertinent qualitative and/or quantitative data from multiple selected studies to foster a single conclusion. Moreover, such studies offer a comprehensive picture of a particular intervention (Ratner, 2006).

The next strongest type of study is a well-conducted single randomized controlled trial (RCT). RCTs are considered level Ib and are experimental studies that randomize participants into treatment and control groups. Other factors accounted for within a high-quality RCT include coders and assessors blinded to group assessment, monitoring of treatment fidelity and use of valid and reliable outcome measures. Systematic reviews of non-randomized quasi-experimental trials or systematic reviews of single subject experiments that document consistent study outcomes would be considered level IIa. The next lowest level is IIb and consists of high quality quasi-experimental trials, lower quality RCTs, and single-subject experiments presenting consistent outcomes across replications. Level III is the next lowest level and includes observational studies with controls, such as monitoring of treatment fidelity. The next weakest level is level IV and includes observational studies without controls. The weakest types of evidence according to Fey and Justice (2007) are expert opinions that are absent of critical appraisal, theoretical background information, or basic research and are considered level V.

EBP is a valuable construct in helping SLPs make important clinical decisions for individual client needs. The SLP should view available research critically as well as consider the preferences, concerns, culture and values of the client and client's family. The incorporation of EBP into the clinician's practice will present the client with the best

intervention possible in respect to his/her diagnosis, values, culture, deficits, etc. as the clinician will have had considered an important array of factors, including systematically judging the studies' quality of evidence.

Chapter 2: Overview of Down Syndrome

Individuals with DS typically present with a similar profile, including deficits in speech and language, and intellectual disability (Roberts, Price & Malkin, 2007). Within this profile, however, there is variability in regard to the severity of deficits each individual presents with and the trajectory of possible improvement within the various areas of deficit. The following chapter will review existing evidence-based research and provide a general overview of the DS profile, including the etiology, the overall communication characteristics (including speech production and intelligibility), cognitive-behavioral phenotype, and developmental trajectory.

BACKGROUND

DS is currently the most common chromosomal anomaly as approximately 6,000 babies are born with DS each year (around 1 in every 700 babies) (Center for Disease Control and Prevention [CDC], 2014). While the impact and severity level of DS ranges from individual to individual, DS is still the most common cause of intellectual disability (Cleland, Timmins, Wood, Hardcastle, & Wishart, 2009). Approximately 1 in every 1,000 adolescents under the age of 19 live in the U.S. equating to a total of 83,000 adolescents and children with DS. This number dramatically increases when including adults with DS with a combined total of 250,700 individuals with DS (CDC, 2014).

Research has identified different causes of DS. The most common cause is trisomy 21 and is present in 98% of DS cases (Roberts, Price & Malkin, 2007). In trisomy 21, the individual has an extra copy of chromosome 21 making his/her chromosome count 47 rather than the normal number of 45. Other causes of DS include translocation and mosaicism (Roberts, Price & Malkin, 2007). Translocation occurs when a portion of chromosome 21 attaches itself to another chromosome. Mosaicism, the least common cause of DS, occurs when chromosome 21 adds an additional copy of the chromosome to other cells (CDC, 2014; Roberts, Price & Malkin, 2007). Research has found maternal age to be a factor in the occurrence of DS as the incidence of DS increases with increased maternal age (Desai, 1997).

Common physical characteristics accompanying DS include growth retardation, congenital heart anomalies, affecting approximately 50% of infants with DS, hypotonia, and dysmorphic facial features, tongue protrusion and reduced oral cavity, ear infection and hearing loss, eye diseases, and obstructive sleep apnea (CDC, 2014; Desai, 1997; Roberts, Price & Malkin, 2007). Moreover, individuals with DS are at an increased risk for acquiring dermal, respiratory and/or gastrointestinal infections. They are also more susceptible to developing leukemia, affecting around 1 out of every 200 individuals. Approximately 30% of DS individuals are affected with dementia after the age of 35 years (Desai, 1997). However, despite these health issues, advances in current health care help to improve life expectancy for individuals, which may exceed 60 years of age (Stancliffe et al., 2012).

SPEECH & LANGUAGE-RELATED DOMAINS

A subset of domains present in individuals with DS likely have a negative impact on speech and language development, including hearing ability in addition to oral motor function and structure.

Hearing Ability

Research has revealed a high prevalence of hearing loss in individuals with DS and these individuals tend to experience middle ear infections more frequently as compared to their typically- developing peers (Rosin, Swift, Bless, & Vetter, 1988). Individuals with DS may present with narrow auditory canals, cranial facial abnormalities, and immune issues that may cause otitis media and respiratory sicknesses (Roizen, 2003). Because fluid within the middle ear is usually seen within otitis media cases, mild to moderate conductive hearing loss is common. This hearing loss therefore has a tendency to impact language development (American Academy of Pediatrics, 2004). Around 67% of children with DS present with at least one type of hearing loss (i.e., conductive, sensorineural, or both) (Roizen, Wolters, Nicol, & Blondis, 1993).

Keiser, Montague, Wold, Maune, & Pattison (1981) found that 74% of adult individuals with DS presented with a hearing loss in at least one ear when tested at a hearing threshold level of 15dB and 38% presented with hearing loss when tested at

25dB. Furthermore, in a study assessing hearing loss in children with DS between the ages of 11 months and 3;10 years, Shott, Joseph, and Heithaus (2001) reported 96% of their 48 participants had experienced one or more ear infections throughout their lifetimes, 83% necessitated pneumatic tube placements, and 81% presented with atypical hearing prior to the start of treatment.

Oral Motor Profile

The oral structure and function of individuals with DS are unique and may be associated with differences in speech intelligibility as compared to individuals without DS (Miller & Leddy, 1998). Such unique oral structure and function features include a small oral cavity, large tongue, and thin, high palate. In addition, differences in innervation have also been documented. Other behavioral correlates include reduced rate of speech or overall speed of articulatory movement, decreased range of motion and weak coordination of the articulators. Together, these features may negatively impact overall speech intelligibility (Miller & Leddy, 1998). Moreover, apraxia of speech (AOS) has been found in individuals with DS (Martin et al., 2009) and therefore, assessment of oral motor abilities and structure is strongly recommended.

SPEECH CHARACTERISTICS AND INTELLIGIBILITY IN DS

A common language profile in individuals with DS is weaker expressive language relative to receptive language abilities (Paul & Norbury, 2012). Moreover, overall speech

intelligibility in individuals with DS is more impaired relative to their cognitive ability (Barnes, Roberts, Long, Martin, Berni & Mandulak, 2009). This section will present information pertaining to speech production and intelligibility of the DS profile.

Speech Production

Speech is more delayed for individuals with DS as compared to language domains (e.g., semantics and pragmatics). However, individuals with DS are a somewhat heterogeneous group who present with varying levels of cognitive and communicative abilities. As such, they exhibit different rates of ability and progress in regard to language and speech abilities (Kumin, 1996).

Dodd and Thompson (2001) investigated the differences in types of speech errors between children with DS and non-DS children who exhibited average intelligence. All were between the ages of 5;7 and 15;10 years. While both groups of children demonstrated production of whole-word inconsistency of speech, non-DS children produced a larger variety of substitutions and produced more phoneme changes on productions of the same word as determined by a variety of measures. Such measures included percentage of whole-word inconsistency (Burt, Holm & Dodd, 1999), percentage of consonants correct (PCC; Shriberg & Kwiatkowski, 1982) and percentage of vowels correct (PVC; Shriberg & Kwiatkowski, 1982). Moreover, the investigators included analysis of the types of articulation changes across trials (i.e., proportion of phoneme consistency across trials, number of different phonemes substituted for any one

phoneme, consonant and vowel deletions and additions). Findings suggested speech errors produced by children with DS are result of a phonological disorder rather than a delay. Moreover, the investigators stated the study presented evidence that the speech disorder characterized in those with DS is not solely a result of their intellectual disability, of hypotonia, or other physiological features.

Speech Intelligibility

Speech intelligibility can be defined as how easy or challenging it can be for a listener to understand the speaker's verbal output (Kumin, 1994). Research reports marked impairments in speech intelligibility in individuals with DS, which involves delayed and disordered articulation ability and inconsistent speech errors. For instance, the individual may produce the same word inconsistently (e.g., "tat/ fat", "cad/ cat") (Kent & Vorperian, 2013). This poor intelligibility may relate to the individual's reduced muscle timing and coordination. Moreover, individuals with DS generally have difficulty with coordinating fast movements of the articulators, such as the tongue, jaw and lips while also voicing (Miller, 1987, 1988).

Overall, the available literature indicates that a great proportion of clients with DS and characteristic speech impairments have variability in addition to accuracy issues (e.g., Kent & Vorperian, 2013). However, little literature precisely designed to support clinicians in making adaptations for this specific population exists (Martin, Klusek, Estigarribia, & Roberts, 2009). One issue that is missing and overall consideration of

intervention approaches is precise information relating to adaptation for specific populations. Accordingly the goal of this study is to attempt to implement CV intervention with an individual with cognitive differences who has the indicated profile. The present pilot study is performed with an adult individual with DS to consider appropriate adaptations to CV intervention.

The present study involves a young adult female with DS. She exhibits inconsistency of speech production (variability of errors) as evidenced from measures of PCC, PVC and proportion of whole-word variability (PWV; Ingram, 2002). In addition to the speech analysis metrics, and according to parent report, the participant presented with low speech intelligibility. It is likely that her inconsistency of speech production is one factor that negatively impacts her intelligibility. While CVA targets inconsistent word productions, accuracy of such word productions was also targeted. Additional measures were included in order to reveal a more comprehensive picture of the effect of CVA and its intended improvement on the speech production and intelligibility of the participant.

Research has revealed that individuals with DS have relatively stronger visual memory as compared to other areas, such as phonological memory skills and overall expressive language (Laws, 2004). Intervention strategies such as the use of pictures and storybooks can play a role in improving learning in persons with DS (Martin, Klusek, Estigarribia, & Roberts, 2009). As result, the intervention protocol included visuals and written versions for each target word practiced during sessions. Each target word was printed in large font and segmented by syllables, each syllable represented by a large

colored dot. Please refer to Appendix 5 for an example of target words and how they were segmented for intervention purposes. This case study may provide information for future SLPs on appropriate adaptations of the CVA for adults with DS.

Chapter 3: Case Study Methods

Studies show distinguishing limitations in speech intelligibility in individuals with DS, including delayed and disordered articulation and inconsistent speech errors (i.e., inconsistent word production of same words) that continues throughout the individual's life (Kent & Vorperian, 2013) Accordingly, this study investigated the effects of the Core Vocabulary intervention (CVA; Dodd, Holm, Crosbie, & McIntosh, 2006) on the speech intelligibility of a young adult with Down Syndrome (DS). The goal of the intervention was to measure whether this young adult who presented with limited speech ability could enhance her functional intelligibility using this approach. Although CVA targets variability, the present study also considered potential adaptations for young adults with DS and therefore, accuracy measures were pursued, as accuracy is a persistent issue for such individuals (e.g., Miller, 1987). The goal of CVA is for the client to consistently and clearly produce a set of words that are used frequently and are meaningful for the client's functional communication. The CVA accomplishes this goal by teaching the client how to put together individual speech sounds in order to produce functional words, and through practice and drill, produce more target intervention words consistently and clearly. Therefore, the goal of this study is to evaluate the efficacy of the CVA for improving speech intelligibility in this adult with DS by establishing consistent word production in order to enhance communicative competence and participation within family and social settings. Effectiveness of the Core Vocabulary intervention on

intelligibility will be experimentally evaluated relative to measurements of reduced variability in target word productions. The following overall question will be addressed: What are the effects of core vocabulary intervention on the reducing variability in production of target words in an adult with DS?

PARTICIPANT

The participant's name has been changed to "Maddie" to protect her identity. The following areas were assessed to provide context of her background and function: Developmental, Social, Medical, Educational, and Speech and Language History. This information was obtained from a case history form completed by Maddie's mother.

Developmental and Social History

Maddie is a 24-year-old English-speaking female who currently lives with her mother and father. The only language spoken at home is English. According to parent report, Maddie reached both the developmental milestones of sitting up without support and crawling at the age of two years. Maddie's mother reported that Maddie first walked without assistance at the age of three years, spoke her first words around the age of three years, and toiled trained around the age of four years. It was also reported that Maddie

tends to be easily distracted, has difficulty organizing tasks/ activities, and demonstrates difficulty in self-cleaning routines.

According to parent report, Maddie's greatest communication deficit is her speech intelligibility. It is reported to be difficult for unfamiliar listeners to understand her speech. Maddie's communication problem hinders her social activities and overall ability to express herself. Maddie's mother and other familiar listeners are able to understand Maddie's communication most of the time. Maddie's speech contains many word repetitions, prolonged sounds and has been reported to struggle with sentence production. In addition, she also has difficulties recalling names of people and places, frequently stumbles over words and gets sounds confused. Overall, Maddie is an outgoing individual and tends to be excited to meet new people and participates in conversations with other individuals.

Medical History

Maddie was diagnosed with Down syndrome at birth resulting in speech, language and cognitive delays. According to parent report, Maddie's birth was remarkable as Maddie's mother experienced a threatened miscarriage and hemorrhaging during delivery. Maddie was born two-weeks early and presented with an endocardial cushion defect and cyanosis (lack of oxygen or abnormal hemoglobin within the blood). At the age of four months, Maddie was hospitalized to undergo heart surgery. Maddie currently presents with pre-diabetes and high cholesterol.

Education, Speech & Language History

Maddie graduated from high school in 2013 at the age of 22 years. During that period, she was enrolled in a life skills program and participated on the drill team, helped to fold laundry for her high school's football team, and worked at a nearby grocery store where she helped stock shelves. She has consistently received speech therapy services throughout her life. Following her graduation from high school, she has received speech services at a private clinic Maddie currently participates in a speech therapy group focusing on social communication. She also participates within individual speech therapy for one hour, once a week in addition to participating within this current research study for 30-minutes, biweekly. She has participated within individual and group speech-language therapy for the past two years. Maddie also continues to participate in dance twice a week with her former high school's dance team she participated in prior to graduating.

According to parent report, her present abilities allow her to indicate meaning by gesture, repeat words spoken by others, the ability to use some spontaneous words, say short sentences/phrases, follow requests, understand simple instructions, and read some signs (particularly ones that correspond to frequent sigh words). Maddie improves her intelligibility when she slows down her rate of speech and/or when she receives a verbal model.

STUDY DESIGN

This CV intervention study consisted of a therapeutic AB case study design, in which "A" consisted of the baseline phase and "B" the intervention phase. While not experimental as the study involved only one participant, it lends support to the effect of intervention within a clinical setting.

SOCIAL VALIDITY

Social validity is a measure used by many researchers and relates to the social importance and appropriateness of treatment goals, procedures and results of a certain intervention. Such a measure provides feedback for future intervention and populations by learning how to more appropriately meet clients' needs and thus, helps to improve therapy for clients. A follow-up conference was conducted between the researcher and participant's mother in order to elicit feedback regarding the current intervention study.

TREATMENT FIDELITY

To properly address treatment fidelity, the researcher followed specific scripted CVA protocol and checked off steps via a checklist (Appendix 2). The researcher completed 100% of each step throughout each session.

PRE-INTERVENTION ASSESSMENT DATA

Prior to the study, clinical assessment was conducted to determine Maddie's

speech and language patterns in word level structured tests. Testing consisted of speech, language and oral motor assessments to assess a variety of abilities, including the *Goldman Fristoe Test of Articulation-2* (*GFTA-2*; Goldman & Fristoe, 2000), the *Preschool Language Scales-5th Edition* (*PLS-5*; Zimmerman, Steiner, & Pond, 2011) and *Oral Speech Mechanism Screening Exam* (*OSMSE*; St. Louis & Ruscello, 1981).

The *GFTA-2* and *PLS- 5* are standardized tests that are used to obtain objective scores relative to the participants' articulation and language skills. In addition to these two standardized assessments, the *OSMSE*, which is an assessment designed to evaluate the structure and function of an individual's vocal tract was also administered. All test forms were de-identified and a code name was used in place of the participant's real name. The *GFTA-2* was also administered following the end of the intervention as a post-treatment evaluation. The administration of the tests and baseline probe sessions were recorded within the UTSHC and were only accessible to the researcher, co-investigators, and research assistant involved within the study based on UT-Austin IRB guidelines for confidentiality.

The *Goldman Fristoe Test of Articulation—Second Edition (GFTA-2*; Goldman & Fristoe, 2000) was administered to assess Maddie's articulation of consonant sounds in single words. The *GFTA-2* provides information on a participant's articulation ability by sampling both spontaneous and imitative speech sound production. Administration time is approximately 15 minutes. The test uses pictures on a stimulus easel to prompt naming that samples major speech sounds in the initial, medial, and final positions of Standard

American English words. The *GFTA-2* is appropriate for individuals, ages 2-21 years. The test yields a measure of the participant's articulation of consonant sounds, allowing for interpretation of articulation errors. Although the assessment allows for comparison of individual performance to national, gender-differentiated norms (Goldman & Fristoe, 2000), standardized scores, percentile ranks nor test-age equivalent scores were used for the purposes of the present study as the participant's chronological age exceeded the chronological age range of the test norms.

GFTA-2 results revealed that Maddie produced most consonants correctly in word final position (68% correct) as compared to the initial and medial positions, 54% and 55%, respectively (Table 1). Maddie produced slightly more substitutions in the medial position (45%) relative to the initial (32%) and final (32%) positions within words. She only produced omissions in the initial position of words (14%). Common substitutions observed throughout the assessment included, /d/ for /ð/ (e.g., /dɪs/ for /ðɪs/), /w/ for /r/ (e.g., /kæwɪt/ for /kærɪt/), and /d/ for /z/ (e.g., /sɪdɔrs/" for /sɪzə-z/). Other substitutions included substituting a variety of sounds for /θ/, such as /w/ for /θ/ (e.g., /wæm/ for /θʌm/), /t/ for /θ/ (e.g., /bæ*t*kæp/ for /bæθtʌb/) and /p/ for /θ/ (e.g., /kæp/ for /bæθ/. Maddie also frequently reduced consonant clusters. Sixteen additional words were analyzed that included consonant clusters. She reduced clusters in 37.5% of the 16 words (e.g., /faʊə-s/ for /flaʊə-z/).

Table 1: *GFTA-2* Baseline Production of Singleton Consonants Within Words

GFTA-2 Results	Initial	Medial	Final
% Correct	54%	55%	68%
% Substitutions	32%	45%	32%
% Omissions	14%	0%	0%

The *Preschool Language Scales—Fifth Edition (PLS-5;* Zimmerman, Steiner, & Pond, 2011) was administered prior to intervention during baseline to assess Maddie's expressive and receptive language skills. The *PLS-5* is a comprehensive interactive assessment of developmental language skills. Items on the test range from pre-verbal, interaction-based skills to emerging language and literacy. It provides information on the individual's attention, interaction, vocal/gestural behaviors, and different levels of play. It is administered using pictures in a stimulus easel and items such as, bowls, a washcloth, and a comb. The administration time was approximately 60 minutes. The test is appropriate for individuals from birth to 7;11 years of age, and therefore, rather than a standard score, the researcher acquired qualitative information regarding receptive and expressive communication abilities of the participant. The *PLS-5* yields a score of total language, auditory comprehension (AC), expressive communication (EC), standard scores, growth scores, percentile ranks, and language age equivalents for interpretation (Zimmerman, Steiner, & Pond, 2011), but were not used for purposes of this study due to the client's chronological age exceeding the age of the test's protocol.

AC tasks within the *PLS-5* evaluate comprehension of basic vocabulary, concepts, morphology, syntax, comparisons and inferences, in addition to emergent literacy. EC

skills consist of labeling, describing, expressing quantity, preposition use, grammatical markers, sentence structures, and emergent literacy abilities. Maddie scored similarly on both the auditory comprehension and expressive communication subtests, receiving a raw score of 38 on AC and 39 on EC.

In regard to AC tasks, Maddie demonstrated that she understood basic concepts (e.g., colors, negatives within sentences), basic spatial concepts (e.g., *in, on, off*, etc.) and basic qualitative concepts within the age range of 4- 4;5 years (e.g., *one*, *some*, *all*, etc.). She also showed the ability to make simple inferences by pointing to illustrations that answered the researcher's question/s (e.g., pointed to illustration of a rain puddle after the researcher asked, "Charlie played outside and got his shoes wet. How do you think he got his shoes wet?"). However, the use of pronouns (e.g., *he, she, his her*, etc.), and more complex spatial concepts (e.g., *under, in back of, next to*, etc.) and relatively complex qualitative concepts (e.g., *more* and *most*) within the age range of 4;5- 5;5 years were much more challenging for Maddie.

EC evaluation indicated that Maddie showed the ability to name a variety of pictures, to combine 3-4 words within her spontaneous speech (e.g., "I love the duck"), used a variety of nouns (e.g., "beautiful", "sick", and "handsome") and verbs (e.g., "dance", "wash", and "count"), but not prepositions. Other abilities included responding appropriately to basic "what and "where" questions (e.g., "What did you eat for breakfast?"). Maddie demonstrated difficulty using plurals and the present progressive tense (i.e., verb + *-ing*). Moreover, naming tasks within the age range of 4-4;5 years of

age were relatively challenging for Maddie, including naming objects described by the examiner and describing the function of objects within the age range of 5-5;5 years. Overall, both Maddie's expressive and receptive skills were similar in age and skill level (approximately around the developmental age of 4 years of age).

The *Oral Speech Mechanism Screening Exam-Third Edition* (*OSMSE-3*; St. Louis & Ruscello, 2000) was administered to evaluate the anatomical structure and physiological function of Maddie's vocal tract. It required approximately 20 minutes to administer. Individuals diagnosed with DS may often have accompanying motor deficits that affect their speech output. The *OSMSE-3* consists of observation and a variety of tasks in order to assess the function of vocal structures. The assessment evaluates a wide range of anatomical structures, some including the lips, mandible, tongue, teeth, soft and hard palate, in addition to diadochokinetic tasks, all of which provide information on the individual's oral and motor speech abilities. This assessment employed a plus-minus scoring system in which plus denoted a normal or expected structure or function.

Maddie's mandible, teeth, hard palate, soft palate, and pharynx all appeared to be structurally intact and functioning within normal limits. Her lips maintained symmetry at rest, and upon modeling a variety of non-speech functional tasks, Maddie demonstrated the ability to produce a variety of movements (e.g., rounded lips, bit lower lip, etc.). She did not have the inability to close lips and fill cheeks with air without nasal and oral emission. Her tongue appeared to function adequately for non-speech functional movements (e.g., ability to move tongue to left and right side), except for ability to move

the tip of her tongue up, suggesting minor range of motion deficits of the tongue. Diadochokinetic rates measure how quickly an individual can accurately repeat a series of rapid, alternating phonetic sounds (e.g. "puh," "tuh," "kuh," "puh-tuh," and "puh-tuh-kuh."). Such evaluation determines the presence of problems in the speech mechanisms that control motor skills or speech planning functions. Maddie's diadochokinetic rates did not meet normed values for chronologically younger children (Table 2). During assessment of diadochokinetic rates on the *OSMSE-3*, she demonstrated an inability to produce the syllables /pʌ/, /tʌ/, and /kʌ/ in isolation and in combination with one another within a timely manner for an individual her age. Moreover, some misarticulations were noted, particularly with /pʌ/ and /kʌ/; Maddie substituted /b/ for /p/ and /g/ for /k/. Findings of this oral mechanism assessment suggest that Maddie presents with possible oral motor control deficits.

Table 2: *OSME-3* Results

OSMSE-3	**Rhythmic**	**Accurate Articulation**	**Repetitions per second**
/pʌ/	No	No (b/p)	1.9
/tʌ/	No	No	.96
/kʌ/	Yes	No (g/k)	1.3
/pʌtə/	No	No	.45
/pʌtəkə/	No	No	.04

INTERVENTION

Intervention Protocol

Maddie received intervention for 30 minutes twice a week for a total of 8 weeks. This is the typical recommended dosage and intervention period suggested for using the CVA (Dodd et al., 2010). Treatment sessions were conducted in a clinic room at the University of Texas at Austin's Speech and Hearing Clinic (UTSHC).

The Core Vocabulary approach (CVA; Dodd et al., 2010), which emphasizes functional vocabulary, was adapted for this participant with Down syndrome who had cognitive impairment. It was adapted to encompass targeting both accuracy and variability. Variability of word production relates to different productions of tokens of the same type (Dodd, Holm, Crosbie, & McIntosh, 2006) while accuracy relates to place or manner errors, and omission of speech sounds within a given word (Macrae, 2012). During the treatment, the researcher selected from 70 total words chosen by Maddie's mother that were deemed functionally 'powerful' to the participant and family. During the intervention phase, she was seen twice weekly for thirty minutes each session for a total of 16 individual intervention sessions targeting the selected target words and phrases. In addition, Maddie's mother was encouraged to provide daily practice to the individual (practice of 10 target words a week).

The beginning treatment session within each week focused on drill work (as structured by CVA, followed by activities/games, such as word bingo to practice the participant's target words. The second session each week focused on assessing the

participant's production of the targeted words to monitor consistent word production according to procedures outlined in the CVA. As structured by the CVA protocol, the participant was asked to produce the set of target words that had been targeted the past week three times each during the end of the second session each week of intervention. Any words that the participant could produce consistently and consecutively three times were omitted from the list of words to be learned and were considered mastered. Words produced inconsistently (i.e., not yet mastered) remained on the list to continue to be practiced the subsequent week.

The overall goal of CVA is to reduce speech variability as an avenue to greater intelligibility. Salient words that Maddie's mother provided were used frequently by Maddie and were functional, but not accurately or consistently produced. Throughout the intervention phase, the researcher tested for generalization by presenting untrained probe words and analyzing their accuracy and consistency (variability). The desired outcome was designated as reduction of variability of untrained words over time.

Selection of Target Words

Maddie's mother created a vocabulary target list for use in CV intervention (Dodd et al., 2010). The target words were deemed to be functionally significant and frequently used by Maddie. They included frequently used names (e.g., Maddie's dog *Pearly*, names of family members, names within Maddie's support team such as *Shirley*), important

places (e.g., Maddie's favorite restaurant *El Rincon*, *address*), favorite things *(e.g., dance, movies),* function words (e.g., *stop, excuse me*), and foods (e.g., *ice cream, enchiladas*). Appendix 6 shows the full list of stimulus words chosen by week of intervention. Five target words were selected and targeted each week. Target words were removed from list to be practiced once they were produced three times consistently and were replaced with another word from the master list of target words.

The initial treatment session of each week concentrated on drill work and sound-by-sound segmentation of the 10-targeted words to elicit "best" (relating to both accuracy and consistency) production of each word. Target words in picture form were used to elicit a high number of repetitions during intervention sessions. During the intervention phase, the researcher selected from 53 total words chosen by Maddie's mother that were deemed functionally 'powerful' to Maddie (Appendix 3). During intervention phases, Maddie's mother was encouraged to participate in daily practice with Maddie (i.e., practice of selected 10 target words a week). Appendix 6 presents the target word breakdown by week. In the second session each week, the researcher reviewed the ten target words with Maddie through drill and target word activity with visuals. Appendix 8 displays an example of a word-based (bingo-themed) activity presented during each session. Within the activity, Maddie was instructed to verbalize the target words seen in the pictures and to match them to their corresponding pictures on the bingo card. Following the review, Maddie was instructed to verbally produce the target words and phrases three times in a row.

DATA COLLECTION PROCEDURES

The start of the intervention was preceded by three sessions of baseline assessments and followed by three sessions of post-treatment assessments over a span of two weeks following the final week of intervention. During each session of baseline and intervention data on the client's speech accuracy and variability was collected via production of generalization probe words at the end of the session. Generalization of word production accuracy and reduced variability in different vocabulary was monitored using these non-treated probe words. Progress on production accuracy and variability in treatment vocabulary and generalization to untrained vocabulary was tracked by the following dependent measures: percent consonants correct (PCC; Shriberg & Kwiatkowski, 1982), percent vowels correct (PVC; Shriberg & Kwiatkowski, 1982), and proportion of whole-word variability (PWV; Ingram, 2002). These will be described in the section below on data analysis procedures. Further accuracy analysis was conducted on percent syllables correct. Non-treated probes were collected every week across the span of the study and were expanded to 20 words to monitor generalization for both accuracy and variability of speech production. See Appendix 4 for a full list of weekly probe words.

Probe Data Analysis

Data was analyzed via analysis of Maddie's production of 20 probe words that

were elicited three times each following one verbal model from the researcher. Analysis using percentage of consonant accuracy (PCC; Shriberg & Kwiatkowski, 1982), percentage of vowel accuracy (PVC; Shriberg & Kwiatkowski, 1982), and proportion of whole-word variability (PWV, Ingram, 2002) described above. All sessions were recorded to collect speech probe data in order to later transcribe data via broad phonetic transcription. One trained speech language pathology undergraduate research assistant assisted in transcribing speech data alongside the investigator.

Percent Consonants Correct

Percent Consonants Correct (PCC; Shriberg & Kwiatkowski, 1982) is an accuracy measure of consonant productions. PCC is calculated by dividing the total number of correctly produced consonants by the total number of consonant targets. PCC measurements were computed and analyzed for untreated probe words targeted during intervention sessions.

Percent Vowels Correct

Percent Vowels Correct (PVC; Shriberg & Kwiatkowski, 1982) is the accuracy measure of vowel and diphthong productions. It is calculated by dividing the total number of correctly produced vowels by the total number of vowel targets. PVC

measurements were calculated and analyzed for untreated probe words targeted during intervention sessions.

Proportion of Whole-Word Variability

The variability of word productions was measured using the calculation of proportion of whole-word variability (PWV; Ingram, 2002). PWV is an appropriate means to calculate the consistency of word forms. It is measured by eliciting a pre-set number of productions for a pre-selected set of words and therefore was appropriate to use within the present study. It is calculated by dividing the number of distinct forms by the number of productions. The investigator, however, averaged the variability for all untrained probe words and weekly target words rather than calculating a score for each individual word.

Maddie was provided three opportunities to verbalize each of the ten probe words each week for a total of 30 words. Because she was given three opportunities to say each word, it allowed for three possible outcomes for each word. Maddie's verbalizations of each word could have resulted in one, two or three distinct forms for the three production opportunities for each given word. Each word is given a number between 1-3 depending on the variability of word forms used and then averaged between the total number of target or probe words. An example is provided in Table 3. In this example, the most variable case is 1c, where three distinct forms were produced. The resulting score is a three, representing maximal variability. The least variable case is 1a in which she

received a 1 for that particular word, as all three productions were similar. All three words (1a, ab, and 1c) are then averaged to calculate a composite variability score, and therefore within the example, she received a PWV score of 2.3.

Table 3: Proportion of Whole-Word Variability Example

Maddie's Productions	# Of different Productions (variability 1-3)
a. Restroom [rʊm] three times	1
b. Friend [frejənz] once, [frɛnts] twice	2
c. Stop [spɑp], [tɑp], [tæp]	3
Total	7
PWV calculation (average)	2.3

Phonotactics

Two dimensions of the phonotactic aspect of this case study were analyzed and included both analysis of word and syllable shape in addition to Maddie's length of words mastered. Analysis of word and syllable shape relate to evaluating the organization of sounds and syllables within one or more words. This analysis viewed the manner in which Maddie accurately sequenced consonants (denoted as /C/), vowels (denoted as /V/) and syllables within probe one-word and two-word targets. For example, if the probe target was /də˞di/, the word shape would be /CVCV/ (consonant-vowel-consonant-vowel). Regardless of the correctness of the consonants or vowels Maddie produced, she still received credit if the sound was a consonant or vowel. For instance, if she produced a

/b/ for /d/ (i.e., /dəbi/ for /dədi/) she received credit for that production as the word shape still matched the target /CVCV/ as both /b/ and /d/ are consonants.

The length of words mastered analyzes the number of words Maddie mastered within the list of target words she practiced throughout CV intervention and is broken down by the number of syllables that each word consisted of. Such words included the targeted salient words that were selected by Maddie's family and probe words collected each week throughout the duration of the study. Therefore, both phonotactic measures relate to word and syllable shapes in addition to variability in her verbal output.

Chapter 4: Results

The overall goal of this study was to assess the impact of CV approach (Dodd et al., 2010) on decreasing variability and increasing speech accuracy for one adult client with DS. In the CV approach, the term 'mastery' is used to clarify when a targeted word is no longer variable and is equated to words produced consistently three times each, regardless of accuracy. Although accuracy is outside the scope of CV intervention technique, it was pursued to understand the potential impact of this intervention approach relative to accuracy and intelligibility because the participant was older and still maintained accuracy deficits. The CV approach has been used in children with speech disorders who have variable speech output patterns. In this study, an adaptation of this approach for a chronologically older individual with cognitive differences was tested. Several different measures were evaluated to assess change in speech patterns. These measures included Maddie's mastery of CV target words, consonant and vowel speech production accuracy measures (PCC and PVC), proportion of whole-word variability (PWV), and increasing complexity of word and syllable shapes. Outcomes for these measures with implementation of CV intervention will be described below.

POST-TREATMENT ASSESSMENT DATA

The *GFTA-2* and *PLS-5* were re-administered as post-treatment assessments and

informally analyzed due to the participant's age exceeding the age limit within the test protocols. In regard to the *PLS-5*, Maddie scored similarly on both the auditory comprehension and expressive communication subtests as she did on these subtests during baseline collection. She demonstrated the same strengths (e.g., shape identification, negatives in sentences, simple inferencing, simple quantitative concepts, etc.) and fell within the developmental age-range of 4-4;5 years for the auditory comprehension component of the test. In regard to expressive communication, Maddie also showed identical strengths as compared to the baseline administration of the test. Some abilities included the capacity to name a variety of pictures, to combine 3-4 words within spontaneous speech (e.g., "Hurley is sick"), the production of a variety of nouns (e.g., "sleepy" and "big"), in addition to verbs (e.g., "eat", "open" and "work). Maddie's expressive communication abilities were consistent with the age of approximately 4 years.

Maddie demonstrated an improvement in the accuracy of her consonant production within single words in post-treatment measures as compared to baseline (Table 4). Maddie produced most consonants correctly in the final position (89.5% correct) as compared to the initial and medial positions, 59% and 65%, respectively (Figure 1). Her consonant accuracy in the final position greatly improved from baseline (68%) to post-treatment (89.5%). Furthermore, a slight improvement was observed in both initial and medial positions from baseline to post-treatment, improving from 54% to 59% for consonants within the initial position and from 55% to 65% correct within the

medial position. Other improvements were also noted including an overall decrease in the percent of substitutions across all three positions. Percentage of consonant substitutions decreased from 32% to 27% in the initial position, 45% to 25% in the medial position and 32% to 10.5% in the final position (Figure 2).

While most measures improved, percentage of omissions slightly increased from 0% to 10% within the medial position from baseline to post-treatment (Figure 3). While substitutions were produced less within the post-treatment measure, the types of substitutions were similar to those produced during baseline including, /d/ for /z/ (e.g., /sɪdɔrs/" for /sɪzə˞z/) and /d/ for /ð/ (e.g., /dɪs/ for /ðɪs/). However, some of the substitutions produced during the baseline administration were not produced during the post-treatment administration (e.g., /t/ for /θ/ as in /bæ*t*kæp/ for /bæθtʌb/), but instead, were produced accurately.

Figure 1: Percentage of Sounds Correct

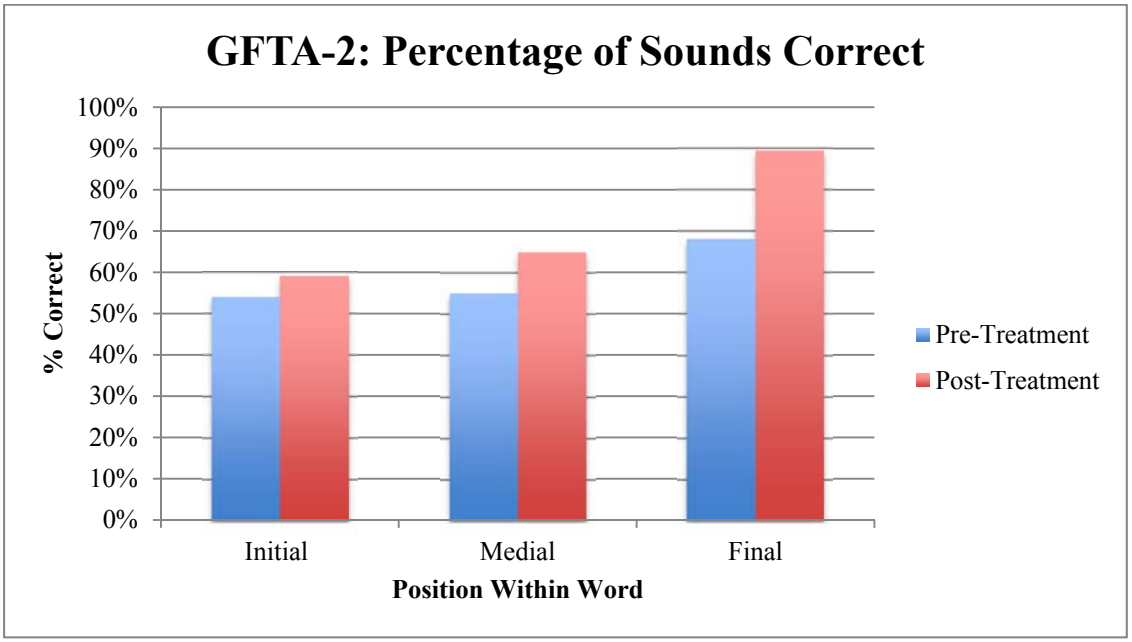


Figure 2: Percentage of Substitutions

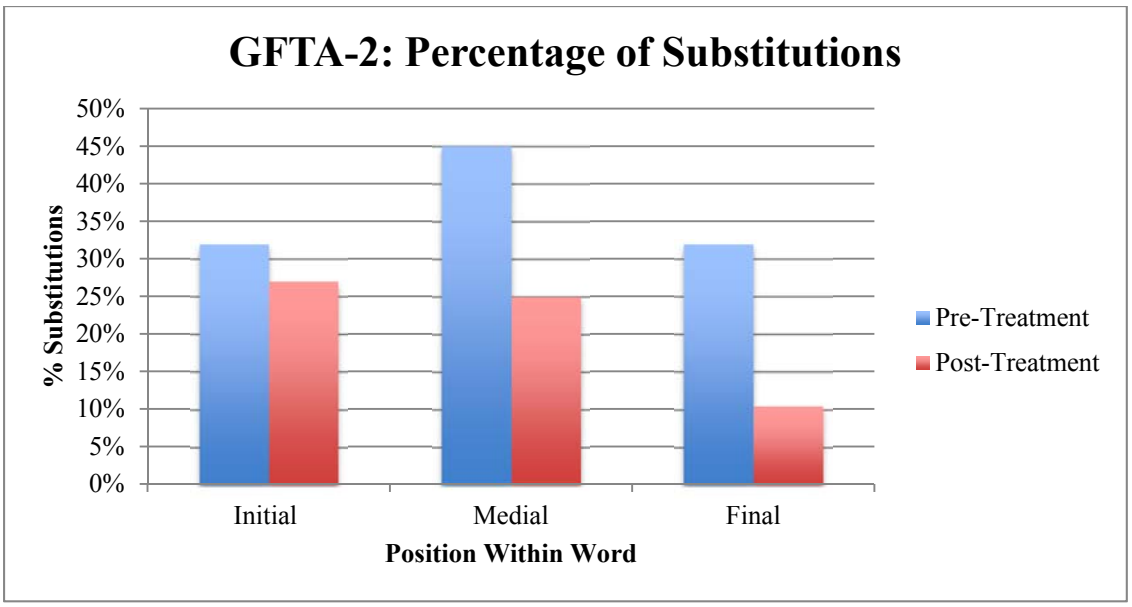


Figure 3: Percentage of Omissions

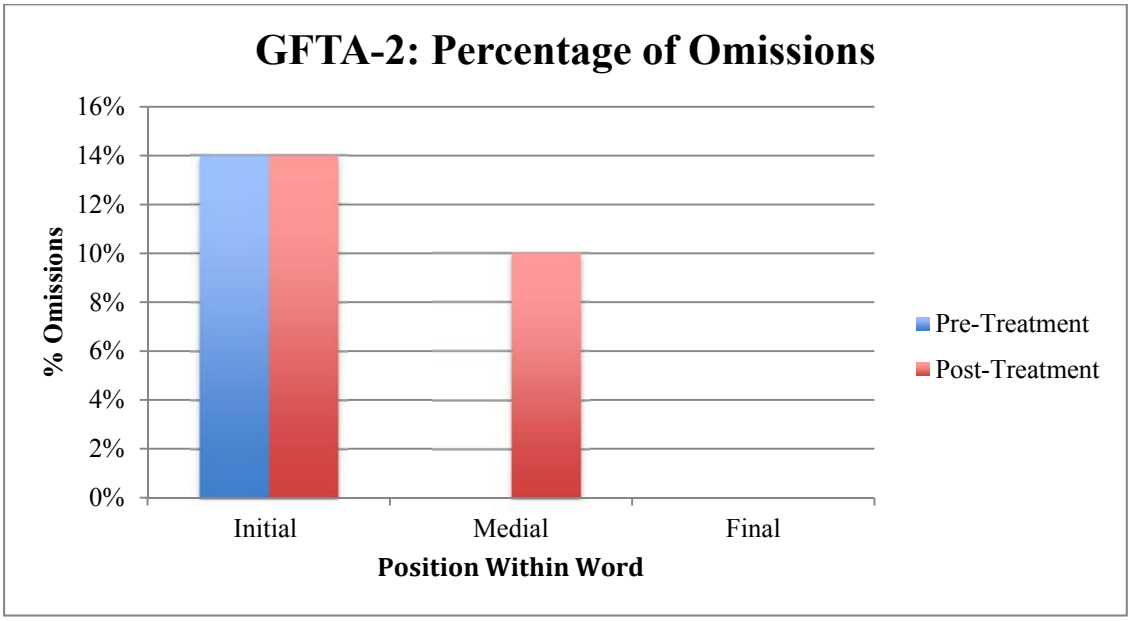


Table 4: *GFTA-2* Post-Treatment Production of Singleton Consonants in Words

GFTA-2 Results	Initial	Medial	Final
% Correct	**59%** *54%*	**65%** *55%*	**89.5%** *68%*
% Substitutions	**27%** *32%*	**25%** *45%*	**10.5%** *32%*
% Omissions	**14%** *14%*	**10%** *0%*	**0%** *0%*

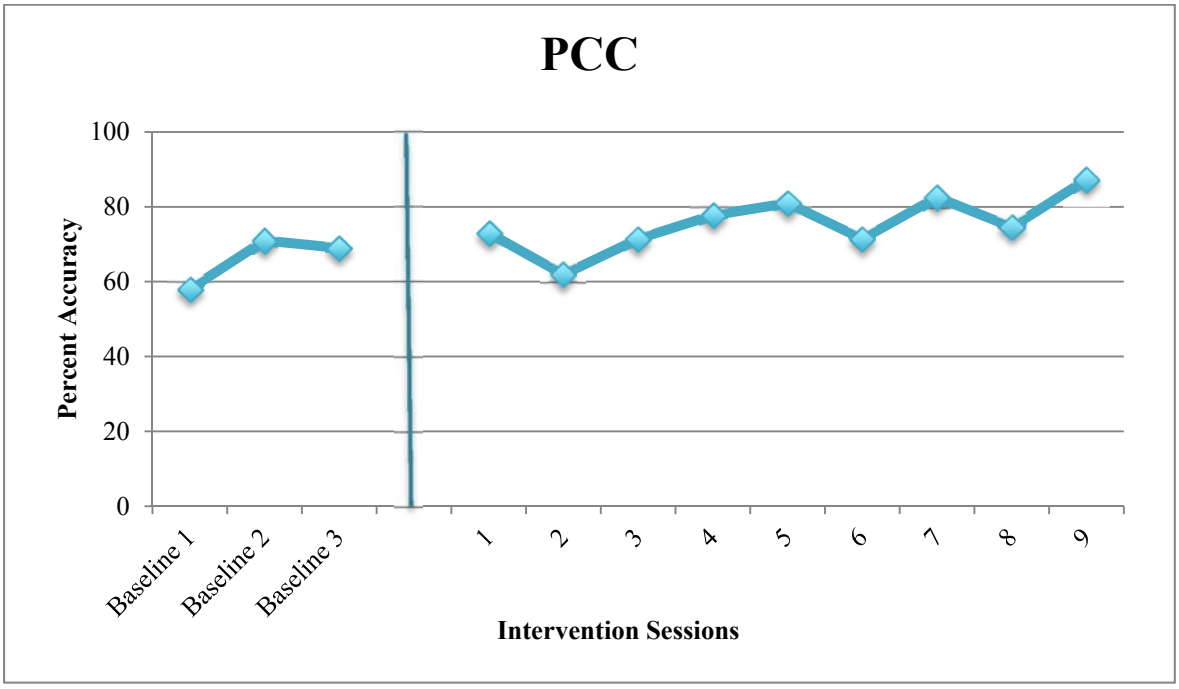
**Note: Post-treatment % printed in black; Baseline % printed in red.*

PERCENT CONSONANTS CORRECT

Percent Consonants Correct (PCC; Shriberg & Kwiatkowski, 1982) is an accuracy measure of consonant productions. PCC is calculated by dividing the total number of correctly produced consonants by the total number of consonant targets. PCC measurements were computed and analyzed for untreated probe words targeted during intervention sessions.

Figure 4 indicates the results of PCC analysis. Phases of the study displayed in the graph include: (1) baseline sessions one, two and three, and (2) the second session of every week during intervention in which Maddie was evaluated on probe word PCC production. Results demonstrate that she was only slightly variable in her accuracy of consonant production within probe words based on such PCC measurements, but maintained a very slight upward slope. Maddie demonstrated a slight overall gradual increase from baseline sessions with an accuracy of 59% at baseline session one, 71% at baseline session two, and 70% accuracy during baseline session three, up to a percent accuracy of 87% in the last session (session nine). However, she demonstrated a particularly low consonant percentage in the second intervention session (62%). Figure 4 illustrates that Maddie maintained gradual increase in percent accuracy starting from session three through session five. She had a percent accuracy of 71% in session three, 78% in session four, and 81% in session five. From there, consonant accuracy dipped twice during session six (71% accuracy) and during session eight (75% accuracy).

Figure 4: Percentage of Consonants Correct



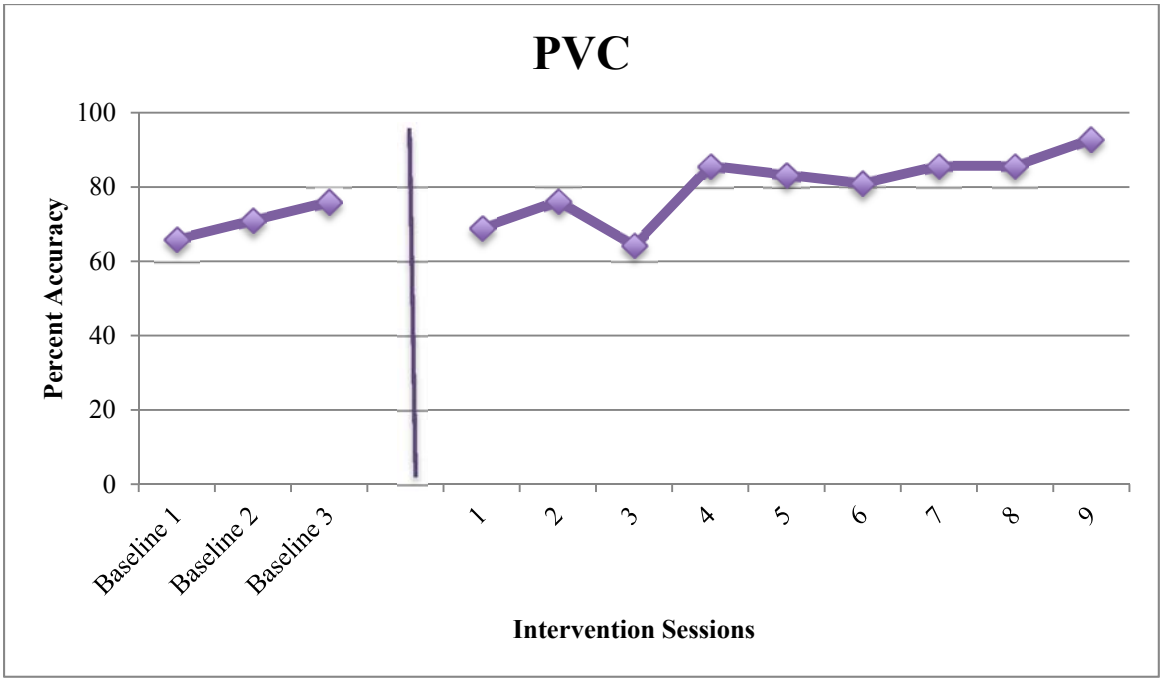
PERCENT VOWELS CORRECT

Percent Vowels Correct (PVC; Shriberg & Kwiatkowski, 1982): is an accuracy measure of vowel and diphthong productions of American English. It is calculated by the total number of correctly produced vowels divided by the total number of vowel targets. PVC measurements were computed and analyzed for untreated probe words targeted during intervention sessions.

Results show the highest percent accuracy of vowels was produced within the 9th session (92.9%) and the lowest percent accuracy within the third session (64.3%). Figure 5 demonstrates that by around the fourth session, Maddie's vowel accuracy appeared to

remain reasonably steady ranging from 81% to 86% from the fourth to eighth session, and increased in accuracy during session nine. Maddie demonstrated more accuracy in vowel production within probe words as compared to consonant production within the probe words, particularly within the session nine, 92.9% versus 87.3%, respectively.

Figure 5: Percentage of Vowels Correct



PCC and PVC results showed the same type of slope and an increase during the last session, but PCC demonstrated a lower end value during session nine, 87% as compared to 93% for PVC. Both accuracy data measures showed a visually apparent increase between the 8th and 9th session. Due to misapprehension of the number of sessions, 9 sessions were conducted. They were retained because accuracy measures in the 9th session revealed overall improvement.

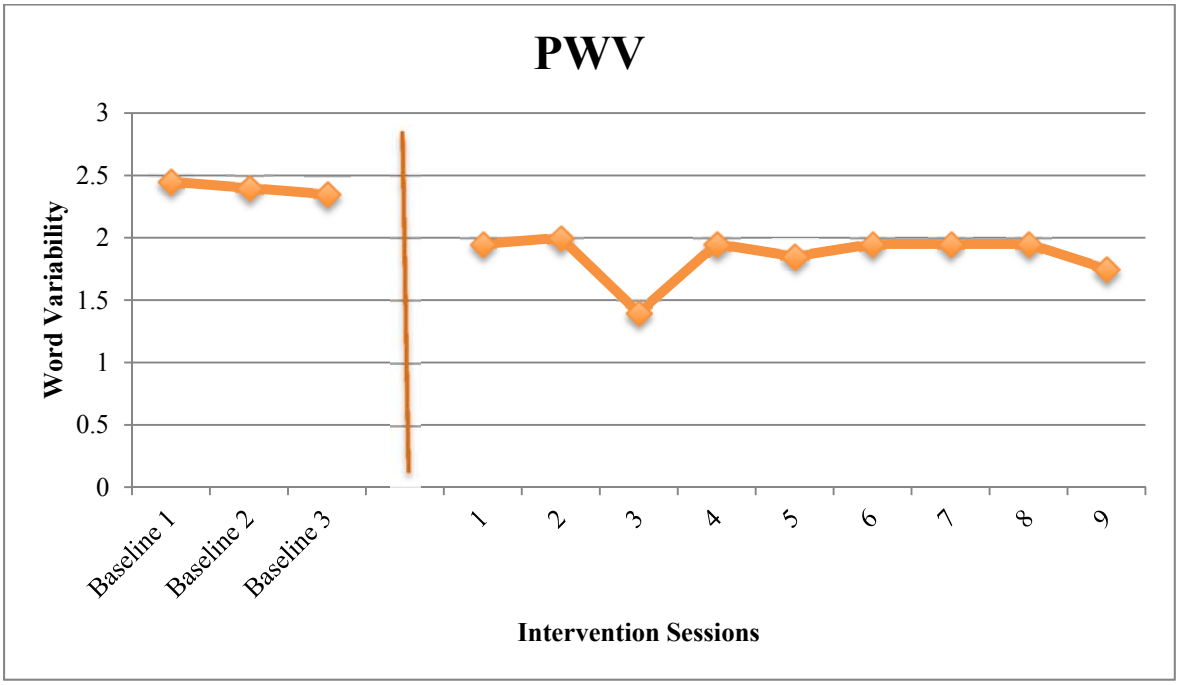
PROPORTION OF WHOLE-WORD VARIABILITY

The variability of word production indicates the number of different ways the participant pronounces a word. Non-treated probe word production was recorded and transcribed using the International Phonetic Alphabet (Ball, Muller, Klopfenstein, & Rutter, 2009) each week throughout the intervention. Whole- word variability (PWV; Ingram 2002) occurs when multiple tokens of the same word are produced differently within the same sample. Therefore, Maddie's repetitions of each probe word could have resulted in one, two or three distinct forms for the three production opportunities for each given word. Variability of word productions was calculated by providing each probe word a number between one and three depending on the variability of word forms used, and then averaged across the total number of probe words.

Between sessions one and five, PWV decreased slowly, indicating that Maddie's production of untreated probe words were becoming less variable and thus, produced more consistently. This is the primary focus area of CV intervention. This trajectory is illustrated in Figure 6. However, from sessions six through eight, no continuing improvement was observed and PWV stayed consistent. Furthermore, while all three measures (PWV, PCC, and PVC) demonstrated relative improvement during the last session (9^{th}) relative to other sessions, there was not a final change indicating in progress for PWV as seen in accuracy measures PCC and PVC. Therefore, the variability measure (PWV) and accuracy measures (PCC and PVC) appear to be somewhat independent of one another in showing Maddie's performance outcome.

Maddie demonstrated more variability in her accuracy profile. Moreover, in regard to PWV, she did not show overall gradual improvement, except when comparing all intervention sessions as a whole to baseline sessions and some slight improvement during the final, ninth session (PWV of 1.6). Figure 6 does not demonstrate an upward trend, but rather a dip in session three in particular (1.4), similar to the dip in session three for PVC. In regard to PWV, however, Maddie's performance was more stable and didn't reveal as much variability related to accuracy.

Figure 6: Proportion of Whole-Word Variability



WORD AND SYLLABLE SHAPES

Two dimensions of phonotactics were analyzed. They relate to the organization of sounds and syllables within a word and include the ordering of consonants, vowels and syllables to create meaning (Velleman, 2002). Such analyses included evaluation of word and syllable shapes, in addition to the length of words mastered (i.e., produced consistently three times, regardless of word accuracy). Each analysis revealed something unique about Maddie's progress toward intelligibility.

The length of words mastered indicates the number of words Maddie mastered within the list of target words she practiced throughout CV intervention. It is broken down by the number of syllables in each word. Such words include the targeted salient words selected by Maddie's family and probe words collected each week across the duration of the study. Both measures relate to word and syllable shapes in addition to variability in her verbal output.

Results For One-Word Targets

Relative to word and syllable shape analysis, Maddie produced shorter and simpler word shape targets with better accuracy compared to longer, more complex word shape target words. For instance, Maddie produced consonant-vowel-consonant (CVC) target word shapes (i.e., haʊs and foʊn) with 94.4%, 88.9% and 94.4% accuracy across rendition one, two and three, respectively.

Compared to CVC word shapes, longer, more complex shapes, such as CVCCCVC (e.g., sændwɪtʃ) were not produced as accurately (0% accuracy across all three renditions). However, results demonstrated that Maddie produced some relatively complex word targets, but did not achieve the same level of accuracy overall as compared to less complex targets (e.g., production of accurate CVCVVCV target shape with 11.1% accuracy as compared to CVC production with 92.5% accuracy).

Moreover, results indicated that Maddie produced word and syllable shapes for probe words more accurately within the second rendition (34%) as compared to renditions one (26.8%) and three (31.7%). Maddie had most success in producing CVCVC and CVC, 100% and 92.5%, respectively, as compared to longer, more complex shapes. She had least success in producing CCVCCV, as in /twɛnti/ (0% accuracy) and CVCCCVC as in /sændwɪtʃ/ (0% accuracy). Overall, Maddie produced probe words with accurate syllable and word shapes with an accuracy of 30.8%. See Table 5 below.

It was interesting to note that Maddie tended to shorten longer, more complex syllable shape target words, such as /pɛpə˞oni/ (CVCVVCV) to /boni/, /poni/, /oni/ (CVC and CVCV shape target words). This pattern may have occurred because it was much easier for Maddie to produce CVC (e.g., /foʊn/) and CVCV (e.g., /də˞di/ and /wɔdə˞/) syllable-shapes, 92.5% and 69.4%,

respectively as compared to more complex syllable shapes, such as CVCCCVC or CVCVVCV, 0% and 11.1%, respectively.

Table 5: Word and Syllable Shapes-One-Word Targets (Probe Words)

Target Word Shape	**# Of Occurrences**				
		T1	**T2**	**T3**	
	Target Word	**Raw Correct/Total %**			**Average %**
CVC	foʊn haʊs	17/27 94.4%	16/27 88.9%	17/27 94.4%	92.5%
CVCV	də˞di wɔdə˞ hæpi jɛlo	27/36 75%	23/36 63.9%	25/36 69.4%	69.4%
CCVC	klin	0/9 0%	2/9 22.2%	1/9 11.1%	11.1%
CVCVC	tʃɪkɪn	9/9 100%	9/9 100%	9/9 100%	100%
CVCCV	bə˞θdɛi θə˞sti pitsə	1/27 3.7%	6/27 22.2%	5/27 18.5%	14.8%
CCVCVC	glæsɪz	2/9 22.2%	0/9 0%	2/9 22.2%	14.8%
CVCCVC	hɑtdɑg	0/9 0%	2/9 22.2%	1/9 11.1%	11.1%
CCVCCV	twɛnti	0/9 0%	0/9 0%	0/9 0%	0%
VCVCVC	ə˞lædɪn	0/9 0%	3/9 33.3%	1/9 11.1%	14.8%
CVCCCVC	sændwɪtʃ	0/9 0%	0/9 0%	0/9 0%	0%
CVCVVCV	pɛpə˞oni	0/9 0%	2/9 22.2%	1/9 11.1%	11.1%
Average %:		26.8%	34%	31.7%	30.8%

Results For Two-Word Targets

Three of the twenty untrained probe words collected each week throughout intervention consisted of two-word targets rather than one-word targets (Table 6). Maddie produced two-word targets with highest word and syllable shape accuracy within rendition two (40.7% accuracy) as compared to renditions one or three, 29.6% and 22.2%, respectively. This outcome was consistent with patterns in one-word productions. Also similar to the results demonstrated from the one-word probe shapes, the word and syllable shapes within the two-word results showed more accuracy in reduplicated CVC CVC target word shape (i.e., /kəl dæd/) with 55.5% accuracy, as compared to other shapes (e.g., 22.2% accuracy for VCCVC CVCV shaped word, /ʌŋkəl bʌbə/; 14.8% for CVCC CV shaped word, /hɛlp mi/). Furthermore, Maddie's overall word and syllable shape accuracy for two-word targets did not decease, but actually stayed consistent with that of her one-word targets (30.8%).

Table 6: Word and Syllable Shapes-Two-Word Targets (Probe Words)

Target Word Shape	**# Of Occurrences**				
		T1	**T2**	**T3**	
	Target Word	**Raw Correct/ Total %**			**Average %**
CVC CVC	kɔl dæd	5/9 55.5%	6/9 66.7%	4/9 44.4%	55.5%
CVCC CV	hɛlp mi	1/9 11.1%	2/9 22.2%	1/9 11.1%	14.8%
VCCVC CVCV	ʌŋkəl bʌbə	2/9 22.2%	3/9 33.3%	1/9 11.1%	22.2%
Average %:		29.6	40.7%	22.2	30.8%

LENGTH OF WORDS MASTERED

The second phonotactic analysis included Maddie's length of words mastered in regard to target words practiced and mastered across the period of intervention. Length of words mastered analyzes the number of words Maddie mastered within the list of target words and is broken down by the number of syllables in each word.

The master list of target words included 53 target words. However, throughout the nine sessions, 29 words were practiced and 24 (82.8%) were "mastered" (i.e., produced consistently three times, regardless of word accuracy). Maddie mastered 100% of the one and two-syllable target words, followed by 75% of 4-syllable words, 57% of 3-syllable words, and 0% of 5-syllable words. One and two-syllable target words were her highest level of achievement, both occurring with mastery of 100% (ceiling level). Following two-syllable words, a steep drop is noted with 3-syllable words (57% accuracy).

However, Table 7 indicates that Maddie's percent mastery then increases for four-syllable words with 75% mastery.

Figure 7: Length of Words Mastered (Target Words)

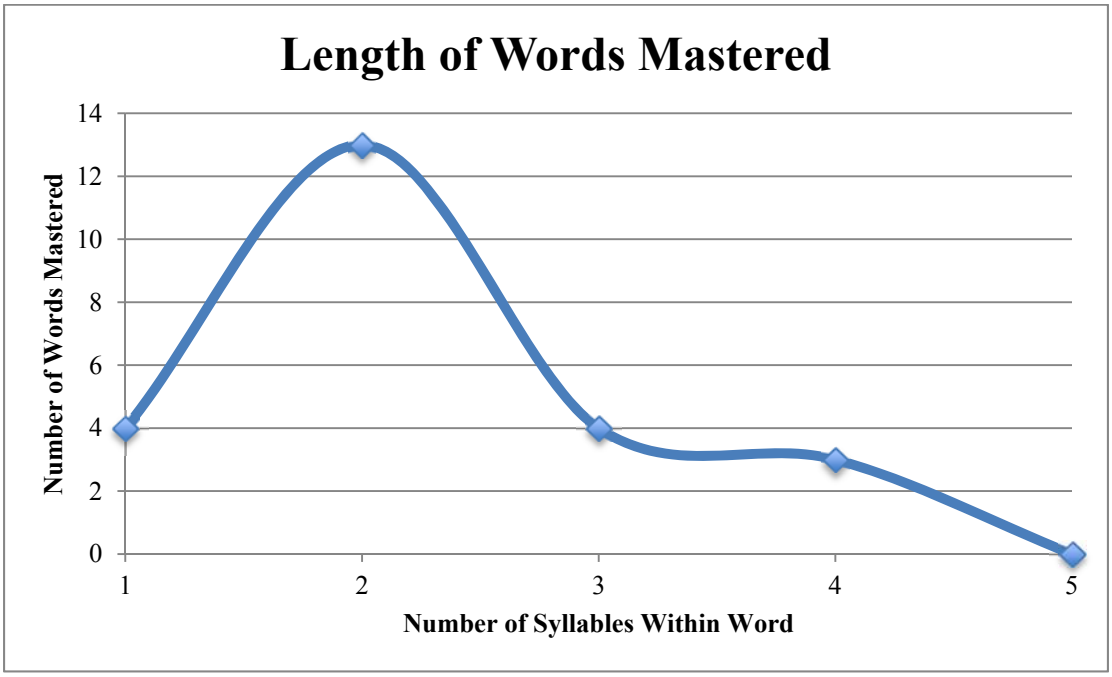


Table 7: Length of Words Mastered (Target Words)

# Of Syllables within Word	# Of Words Mastered	# Of Words Practiced	% Words mastered
1-Syllable	4	4	100%
2-Syllable	13	13	100%
3-Syllable	4	7	57.1%
4-Syllable	3	4	75%
5-Syllable	0	1	0%
Total	24	29	82.8%

Social Validity:

In a follow-up conference, Maddie's mother strongly emphasized that she was pleased with Maddie's improvement. She felt that CV intervention focused on what was important to Maddie (i.e., functional words and words of interest to Maddie in her daily life). This qualitative perspective parent report on Maddie's improvement demonstrates the potential functional outcome CV intervention might have in other adult individuals with DS.

OVERALL SUMMARY OF RESULTS

Numerous measures were pursued to understand the efficacy of CV intervention on variability and accuracy in a young adult with DS and persistent speech patterns differences impacting her intelligibility in functional speech output. Some measures more robustly showed improvement while others didn't indicate the same change over time. For instance, Maddie demonstrated more accuracy in vowel production within probe words as compared to consonant production, particularly within the last additional session, 92.9% versus 87.3%, respectively, and therefore vowels were a relative strength in her system. Maddie demonstrated the lowest PCC score in session two. However, in regard to PVC, her lowest percentage was displayed in session three. In regard to PWV measurements, Maddie's performance was more stable than accuracy measurements PCC and PVC. Her variability decreased only very slightly, which is a continuing issue

related to her functional intelligibility.

In regard to length of target words mastered (i.e., word produced consistently three times, regardless of word accuracy), a precipitous drop was noted between two-syllable words and three-syllable words, 100% and 57% respectively. Such a drop suggests that 2-syllable words are her upper boundary for speech intelligibility, which is consistent with target word-shape measurement results (e.g., 100% accuracy for 2-syllable, CVCVC-shape word targets /tʃɪkɪn/). While Maddie's percent mastery then drops for three- syllable words (57.1% mastery), her mastery percentage greatly increases for four-syllable words (75% mastered).

Another pattern was observed within phonotactic measures. Between the one and two-word target measures (assessing untreated probe word production), the second rendition was most accurate compared to the other two renditions. For instance, Maddie had 34% accuracy in rendition two for one-word targets as compared to rendition one and three, 26.8% and 31.7%, respectively. In regard to two-word targets, she produced probe words with a word and syllable shape accuracy of 40.7% accuracy in rendition two, whereas accuracy in rendition one and three where 29.6% and 22.2%, respectively. Overall, however, both one-word and two-word shapes were produced with an overall accuracy of 30.8%

Chapter 5: Discussion

OVERVIEW

The overall goal of this pilot case study was to implement CV intervention with one young adult with Down syndrome (DS) to examine the efficacy of this functional intervention with adults who have persistent speech disorder associated with cognitive differences. CV intervention is designed to decrease variability of word production by increasing the consistency of same word productions (Dodd, Holm, Crosbie, & McIntosh, 2010). However, accuracy measures were also included relative to increasing intelligibility and possible adaptations for adults with DS, which is broadens the original intent of CV intervention.

Maddie, a young adult with DS, was chosen for this study because she presented with low intelligibility in addition to DS. Researchers have indicated that individuals with DS typically exhibit inconsistent speech errors, in the form of multiple error types (e.g., Borghi, 1990; Dodd & Thompson, 2001). Analysis of change in Maddie's speech patterns over the course of intervention included a variety of speech measures including phonotactics, and other accuracy and variability measures in order to gain a greater understanding of the effect of CV intervention techniques on Maddie's speech consistency and accuracy.

VARIABILITY AND ACCURACY OUTCOMES

Overall, study findings revealed that multisyllabic word targets utterances were produced with less accuracy compared to one-syllable targets (e.g., 11.1% for CVCVVCV-shaped word targets versus 92.5% for CVC- shaped word targets; refer to Table 5 and Table 6 for one versus two-word shaped targets). In general, accuracy did not decrease (both 30.8% accuracy for both one-word and two-word targets; refer to Table 5 and Table 6). Such results suggest that Maddie might be able to accomplish more complexity with continued targeted intervention. There is some positive prognosis indicated by these results. While Maddie didn't demonstrate a great increase based on the PCC and PVC accuracy measures throughout intervention, a longer period of intervention would be warranted to continue to increase her accuracy.

In regard to length of target words mastered, while Maddie's percent mastery dropped for three- syllable words (57.1% mastery), her mastery percentage greatly improved for four-syllable words (75% mastered). A possibility for why four-syllable words were produced with greater percent mastery is that perhaps they were more familiar or salient for individual reasons related to her environment as compared to three-syllable words (e.g., familiar people's names). Her performance within this particular analysis is likely due to her developmental age and therefore is consistent with her developmental, rather than her chronological age.

INTERVENTION ADAPTATION FACTORS

The goal of this pilot study was to consider the potential for adaptation of this speech approach designed originally for young children to adults who have DS. Several insights emerged relating to adaptations of the CV approach. One of the adaptations was that fewer words were mastered than might be expected for an individual at Maddie's chronological age of 24 years. A possible adaptation is that fewer words may be targeted for individuals with similar profile presentations than would be expected for the standard CV protocol (10 targeted words a week). However, the words were salient and were considered to be functionally powerful in increasing Maddie's intelligibility according to her parent's report.

Another aspect of adapting CV for implementation with adults with DS relates to the time frame or length of intervention. Generally, there are two ways to conduct CV intervention. One method is to conduct the therapy within a limited time frame (e.g., across a period of 8 weeks, consistent with CV protocol), or, secondly, to conduct therapy across a longer time frame (i.e., across a period of more than 8 weeks). While most researchers conduct CV intervention across a limited time frame and perform a later follow-up (e.g., van Bysterveldt, Gillon, & Foster-Cohen, 2010), the protocol for this study inadvertently included 9 sessions (i.e., 9 weeks) instead of the 8 standard sessions (i.e., 8-week period). However, the 9th session was retained for data analysis as it revealed most improvement based on study measures. When analyzing the standard 8 sessions, not as much improvement was demonstrated until the 9th session was analyzed.

This outcome would suggest that perhaps a limited time frame as suggested by the CV protocol might not provide a complete picture of improvement. A longer time frame for this intervention may be an appropriate adaptation for young adults with DS.

Maddie's variability (PWV) may present a more difficult issue and may also take a longer time to address in intervention than the time window in this study. The persistence of Maddie's level of variability indicates however, that it needs to continue being included within her current speech goals to increase intelligibility. Variability has not yet been addressed prior to the present intervention and may take a longer time period than the 8-week protocol or the nine weeks within the present study to reduce her variability and thus impact her speech intelligibility. Research on this population has documented it may take a longer time period to achieve results when a cognitive delay is present (e.g., Evans-Martin, 2009).

Another consideration relative to adapting CV intervention for individuals with DS is attention status. Maddie was often distractible in intervention sessions for a variety of reasons. Distractibility included several issues: events prior to her session (e.g., playing with her dog in the car and clinic lobby, prior conversations held with her mother, individual and at times group speech therapy sessions, in which he attended different social events and learned about different topics such as science, etc.), events after her session (e.g., getting to attend a sleepover with her nieces, getting to go shopping with her mother, talking about upcoming holiday plans, etc.), and her thoughts about food. These are issues for Maddie that may be individually cogent to achieving

optimal session outcomes. A couple of times across the intervention period, there were unusually focused sessions. There were dips in sessions across measures and this might have been attributed to some changes in her state that were a consistent issue during intervention. It should be noted in planning future intervention that decreased attention seems to a reported factor in individuals with DS (e.g., Ekstein, Glick, Weill, Kay & Berger, 2011). As a result, attention is a salient issue that influences both session level and overall intervention outcomes. In Maddie's case, certain issues were present that may have decreased her attention and resultantly affected her response to intervention (e.g., thinking about events that would happen following a session, such as lunch plans with her uncle, having a sleepover with her nieces, etc.).

Last, there have been some studies suggesting memory is an issue in the DS population (e.g., Brock & Jarrold, 2005) and therefore memory differences could have contributed to the outcomes for Maddie in the present study. In regard to word and syllable shape measures, a pattern was noted between one and two word targets measures. The second rendition of a word was most accurate relative to the other renditions. A potential hypothesis is that the first rendition was task-related and thus, Maddie may have been working on comprehending task direction. However, during the second rendition, she started moving toward more accuracy, while in the third rendition, she may have not been able to hold attention or store the targeted word in her memory long enough (task difficulty). There may have been a memory component required that made this particular task more difficult and therefore, it would be interesting to explore

memory issues in an assessment in reference to her capacities. Consequently, it would be of interest to study this particular discipline relative to appropriate intervention adaptations for this population.

FUTURE RESEARCH

Future research on adaptations of current interventions for adults with DS should include a larger number of individuals. The present study included effects of intervention in the speech of one young adult. Moreover, preliminary support from this analysis demonstrates that prolonging the length of the CV intervention for individuals with DS or perhaps other disorders presenting with similar cognitive or social profiles in young adults with developmental disabilities may possibly increase the chances of an individual's benefiting from this intervention approach. Furthermore, the present outcome supports previous research (e.g., Dodd, McCormack, & Woodyatt, 1994) that clinicians working with individuals with DS should address the individual's inconsistency of word production first, and thus consider CV intervention, and then subsequently provide intervention targeting more specific speech goals including sound and syllable or word level errors.

CV intervention was used to assess its efficacy in improving the speech intelligibility of an adult with DS, and to evaluate the power of possible adaptations for this population given the findings. While CV intervention was originally developed for

children, adults with DS present a different population than children and therefore, adaptations to such intervention are warranted to highlight the intervention's expectation and functionality. Results suggest that when personalized to the developmental level of the adult, CV intervention might be a potentially powerful and functional intervention for both accuracy and variability. Such factors to consider when adapting CV intervention for an adult presenting with this cognitive profile include implementing fewer target words each week, lengthening the timeframe of intervention (i.e., more than eight weeks of intervention), in addition to considering both the attentional status of the client and memory differences.

APPENDICES

Appendix A: Types of Cues & Prompts Presented by Examiner During Intervention

Types of Cues/ Prompts	Description	Example
Phonemic cue	Verbal cue where only phoneme was provided	E.g., "W" for "Wizard of Oz"
Voice Inflection cue	Verbal emphasis placed on important or missed syllable/s	E.g., Maddie: "___ard of Oz"; Researcher: "WIZard of Oz"
Partial Verbal cue	Verbal cue where only part of verbal elicitation is provided	E.g., "Wiz" for "Wizard of Oz"
Full Verbal cue	Verbal cue where complete response is presented	E.g., "Say Wizard of Oz" for "Wizard of Oz"
Visual cue	Presentation of visual (e.g., picture, written form of word, etc.), act of pointing (e.g., to specific syllable unit)	E.g., Researcher presents visual (photo) of the movie *Wizard of Oz* and points to the written form for Maddie to segment and verbalize; if Maddie skipped over a syllable within phrase, researcher pointed to missed syllable and instructed Maddie to verbalize again
Hand-over-Hand prompt	Physically guiding participant through response	E.g., Researcher holds Maddie's hands to physically clap along to multisyllabic word; researcher holds Maddie's hand/ finger to touch dots while verbalizing multisyllabic word/ phrase
Modeling prompt	Imitation of correct verbalization by examiner	E.g., Researcher: "Wizard of Oz"

Appendix B: Core Vocabulary Approach Protocol

Core Vocabulary Approach Checklist:

- ☐ 1.) 30-minute session in which target words are practiced
- ☐ 2.) Practice up to 10 target words
- ☐ 3.) Approximately 100 responses (verbal elicitation of target words) within 30-minute session
- ☐ 4.) Teach target words sound-by-sound (cues including syllable segmentation, phonemic cuing, voice inflection cue, etc.)
- ☐ 5.) Use of visual aids and written form of target words
- ☐ 6.) Second session each week: continuation of practice of the target sounds (e.g., syllable segmentation, etc.)
- ☐ 7.) Continued use of visual aids and written form of target words (use consistently & in same manner across sessions)
- ☐ 8.) Only the 10 target words practiced for that week will be taught and emphasized. These 10 words will also be presented to KeMe's mom in order for them to continue practicing specified words for that week
- ☐ 9.) End of second session: ask KeMe to produce 3x the set of target words for that week and any of the words produced consistently (3x the same way regardless of accuracy) will be considered mastered and removed from target word list. New target word/s will then be in place of mastered word/s for next week. Any words not mastered will continue to be targeted the following week.

Appendix C: Full List of Target Words/ Phrases

1.	Maddie*	**28.**	Enchiladas
2.	Mom	**29.**	Steak
3.	Dad	**30.**	Nachos
4.	Derek*	**31.**	Guacamole
5.	Morgan*	**32.**	Sour Cream
6.	Rachel*	**33.**	Dance
7.	Samantha*	**34.**	Swim
8.	Niece	**35.**	Bowling
9.	Gran	**36.**	Cards
10.	Pa	**37.**	Movie
11.	Mary*	**38.**	DVD
12.	Shirley*	**39.**	CD
13.	Pearly*	**40.**	Grease
14.	Brother	**41.**	Grease Two
15.	Martha*	**42.**	Dance With Me
16.	Friend	**43.**	Wizard of Oz
17.	Excuse me	**44.**	Singing in The Rain
18.	Stop	**45.**	Hair Spray
19.	Restroom	**46.**	Lion King Two
20.	Restaurant	**47.**	Cinderella
21.	El Rincon	**48.**	Beauty and The Beast
22.	Address*	**49.**	Belle
23.	Temple*	**50.**	Enchanted
24.	Texas	**51.**	Banana
25.	Sweet Tea	**52.**	Ketchup
26.	Chips	**53.**	Tacos
27.	Ice Cream		

Note: *Indicates pseudonyms are used

Appendix D: Full List of Weekly Probe Words

Probe Words			
1.	Glasses	**11.**	Uncle Bubba
2.	Dirty	**12.**	Aladdin
3.	Clean	**13.**	Chicken
4.	Phone	**14.**	Yellow
5.	Birthday	**15.**	Pepperoni
6.	Call Dad	**16.**	Sandwich
7.	Water	**17.**	Hot dog
8.	Thirsty	**18.**	House
9.	Happy	**19.**	Pizza
10.	Help me	**20.**	Twenty

Appendix E: Example of Target Words with pacing/ segmentation cues

Appendix F: Target Words Used Throughout Intervention

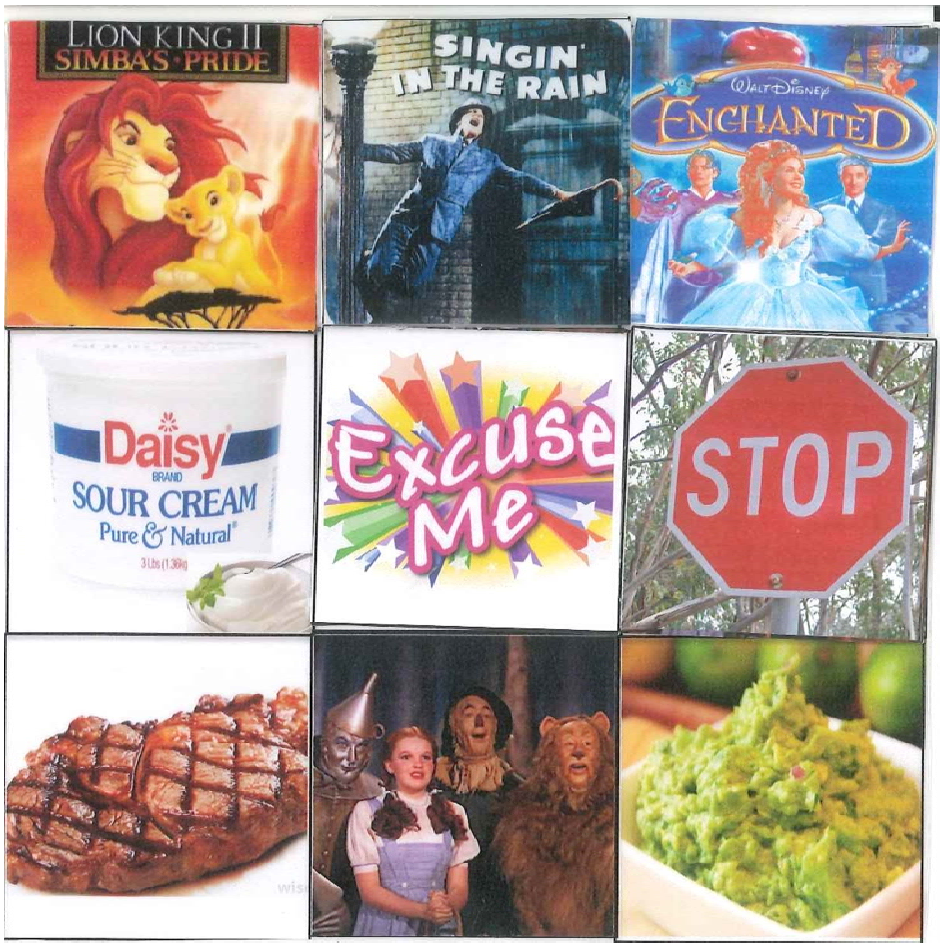
	Intervention Sessions by Week								
	Week 1	**Week 2**	**Week 3**	**Week 4**	**Week 5**	**Week 6**	**Week 7**	**Week 8**	**Week 9**
Target Words	Maddie	Maddie	Maddie	Ketchup	Guacamole	Guacamole	Guacamole	Guacamole	Guacamole
	Morgan	Morgan	Morgan	Morgan	Steak	Steak	Steak	Steak	Swim
	Derek	Samantha	Samantha	Samantha	Samantha	Samantha	Enchanted	Enchanted	Enchanted
	Shirley	Shirley	Shirley	Tacos	Tacos	Tacos	Grease 2	Dance With Me	Panther Drive
	Chips	Pearly	Pearly	Pearly	Sweet tea	Excuse me	Excuse me	Excuse me	Excuse me
	Ice cream	Ice cream	Lion King 2	Lion King 2	Lion King 2	Lion King 2	Lion King 2	Lion King 2	Lion King 2
	Enchiladas	Enchiladas	Restroom	Restroom	Restroom	Stop	Stop	Stop	Stop
	Bowling	Bowling	Rachel	Rachel	Sour cream	Sour cream	Sour cream	Sour cream	Sour cream
	Wizard of Oz	Wizard of Oz	Wizard of Oz	Wizard of Oz	Wizard of Oz	Wizard of Oz	Wizard of Oz	Wizard of Oz	Wizard of Oz
	Hair Spray	Singing in the Rain	Singing in the Rain	Singing in the Rain	Singing in the Rain	Singing in the Rain	Singing in the Rain	Singing in the Rain	Singing in the Rain

*Note: *Mastered words printed in red. Pseudonyms within table; real names used as targets (phonologically similar)*

Appendix G: Research Probe Data by Week

Intervention Sessions by Week												
	Baseline 1	**Baseline 2**	**Baseline 3**	**Week 1**	**Week 2**	**Week 3**	**Week 4**	**Week 5**	**Week 6**	**Week 7**	**Week 8**	**Week 9**
PCC	58.0	71.0	69.0	73.0	61.9	71.4	77.7	80.9	71.4	82.5	71.6	87.3
PVC	66.0	71.0	76.0	69.0	76.2	64.3	85.7	83.3	81.0	85.7	85.7	92.9
PWV	2.45	2.40	2.35	1.95	2.00	1.40	1.95	1.85	1.95	1.95	1.95	1.75

Appendix H: Example of CVA Word-Based Activity



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