OFFERING CHOICE: THE ROLE OF AUTONOMY IN TREATMENT FOR CHILDREN WITH CHILDHOOD APRAXIA OF SPEECH

A Thesis
Submitted to
the Temple University Graduate Board

In Partial Fulfillment
of the Requirements for the Degree
MASTER OF ARTS

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May 2024

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ABSTRACT

The purpose of this study was to evaluate the role of client-directed choice in treatment for a child with childhood apraxia of speech (CAS), as compared to a lack of client-directed choice. One way to exercise control over practice conditions is through incidental choices. In studies of non-speech motor learning, offering opportunities for incidental choice to the learner, thus increasing their autonomy, has been shown to enhance learning (Wulf & Lewthwaite, 2016). Increasing client engagement and buy-in could maximize their level of motivation in treatment, and lead to better learning outcomes.

This study used a single-case, alternating treatments design consisting of two conditions (Child-choice and Clinician-choice). The treatment employed prosodic variation during speech practice; the speech practice involved the ASSIST protocol (Maas et al., 2022). Options for prosodic variation were presented using the name and vocal characteristics of three different emotional tones (happy, sad, and angry). Each treatment session alternated between two conditions. In the first condition, the participant chose the tone in which to practice each target. In the second condition, the clinician chose the tone. The primary outcome measure was accuracy, as judged by blinded listeners from recordings. Effect sizes were computed and compared between conditions to address the primary research question (Does client-directed choice enhance learning compared to clinician-directed choice?). Comparison between treated item sets and untreated item sets provided a replication of the overall ASSIST protocol. Preliminary results to date showed no clear effects for either autonomy or treated vs. untreated sets.

To Bean and Sy, for the laughs, love and perspective amidst this study.

And to my departed Pooka and Roo, for their solace and affection.

Grateful always.

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ACKNOWLEDGMENTS

I would like to thank my thesis advisor, Dr. Edwin Maas, a million times over for letting me be curious, providing indelible support, and offering his insight and expertise throughout this project. It could not have been done without his invaluable guidance. He gave me the courage to trust myself and to use my own voice, in research and beyond—for that I am eternally grateful.

I also would like to thank the extraordinary members of my thesis committee, Dr. Lauren Burrows and Susan Caspari. In addition to contributing their brilliance to this study, they have helped shape who I am as a clinician throughout my time in the program. I feel incredibly lucky to have learned so much under their mentorship.

To Teodora, thank you for being the keeper of the data, always brightening my day, and lending a listening ear. I do not know what I would have done without your help. I would also like to offer my deepest acknowledgements to my data analysts: Grace Riley, Karishma Peaks, Juliana Jacob, Lina Neilson, for their quick work on this.

I am immensely grateful to my participant and their family for their involvement and dedication. Additionally, I would like to thank all my professors and supervisors throughout my time at Temple, who inspired me to ask questions and venture into research. I feel incredibly fortunate to have such a strong support system around me.

Finally, I want to extend my heartfelt gratitude to my family, particularly my mom, Nana and brothers, whose love and encouragement propelled me forward. To my partner, Hussein, for their constant care and sweetness; the Brain Cell, and my Baltimore Girls for always cheering me on. I am in absolute awe of each of you and the support you have given me. I would not be where I am today without you all.

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CHAPTER 1

INTRODUCTION

Childhood apraxia of speech (CAS) is a neurogenic motor speech disorder that impacts children and their learning in a multitude of ways, due to impaired speech motor planning (ASHA, 2007; Caruso & Strand, 1999). Salient features of CAS include inconsistent vowel and/or consonant errors upon repeated production, difficulties with smooth transitions between articulatory placements, and atypical prosody. Its presentation may also include facial groping movements, voicing errors, difficulty with imitation of simple words, vowel and consonant distortions, and segmentation (Ballard et al., 2010). It has been noted in prior literature that some children with CAS experience slow progress in therapy and may require extensive services extending from childhood into adolescence (Forrest, 2003; Ballard et al., 2010).

Children with CAS often need more treatment than children with other speech sound disorders (SSDs) (Campbell, 1999) and an innumerable number of factors can limit how much therapy a child can receive (i.e., accessibility, caregiver schedule, medical needs) (McAllister et al., 2011). Additionally, children with CAS have been shown to have a higher likelihood of developing fine and gross motor deficits and comorbid language disorders, even when compared to children with other SSD (Lewis et al., 2004; Iuzzini-Seigel, 2019). In contrast to peers without SSD, children with CAS also have an increased likelihood of experiencing challenges with spelling and reading (Gillon & Moriarty, 2007; Lewis et al., 2004; Miller et al., 2019; Snowling & Stackhouse, 1983). It is in the child's best interest to maximize treatment benefits in the shortest possible amount of time so that deficits resulting from CAS are remediated before they impact academic (i.e., literacy, spelling, writing) or later vocational growth. Refining our treatment of CAS could serve to mitigate these impacts on children.

How is CAS currently treated? Treatment of CAS involves training the motor speech system to successfully plan the appropriate movements and timing to create more accurate speech. A few motor-based treatment programs have been researched and trialed for CAS intervention, including Rapid Syllable Transition Training (ReST; Murray et al., 2015), the Nuffield Dyspraxia Program, 3rd Edition (NDP3; Murray et al., 2015), and Dynamic Temporal and Tactile Cueing (DTTC) (Strand et al., 2006; see Murray et al., 2014, for a review). ReST, a treatment protocolized for CAS intervention, involves practicing pseudowords to improve speech production accuracy and consistency, while the NDP3 uses real words and picture stimuli (Murray et al., 2015). DTTC also uses real words as targets and the treating SLP scaffolds cueing for the client until they no longer require the cues (Strand et al., 2006). The idea of this cueing being “dynamic” refers to the SLP’s tailored response to the client’s cueing needs to build their motor-planning skills throughout practice. Scaffolding refers to either increasing support with more cues or fostering independence by decreasing cues.

These three treatments have some of the same elements: a focus on movement, rather than individual sounds; treatment targets and feedback uniquely tailored to meet the client’s individual goals; and a lot of high-frequency practice. Research on CAS and motor learning suggests that the best learning occurs with high frequency treatment (Murray et al., 2015; Edeal & Gildersleeve-Neumann, 2011). Thomas et al. (2014) recommend two sessions per week at the very minimum. ReST is typically delivered for four one-hour sessions for 3-4 weeks (McCabe et al., 2020; Thomas et al., 2016). Even at a lower dosage, treatment is recommended twice a week for six weeks (Thomas et al., 2014). The recommendations for high frequency treatment across these treatment programs is due, in part, to the efforts to incorporate the principles of motor learning.

Motor Learning

The principles of motor learning (PML) are thought to be an important consideration when designing CAS treatments. PML refers to how certain practice conditions and feedback affect motor learning (e.g., variable practice leads to better learning than constant practice). These principles were originally established in nonspeech motor learning. As such, much of the evidence surrounding motor learning has investigated nonspeech tasks (e.g., dart-throwing, golf swing) in people without motor learning deficits (Ikudome et al., 2019). However, a review suggested some aspects of the PML could be potentially applicable when treating motor speech disorders (Maas et al., 2008). As an extension to PML, Wulf and Lewthwaite (2016) developed and studied the OPTIMAL (Optimizing Performance Through Intrinsic Motivation and Attention for Learning) theory of motor learning to further enhance learning.

Current research on the OPTIMAL theory found that motor learning and performance are influenced by a variety of motivational and attentional factors, including autonomy (Wulf & Lewthwaite, 2016). Autonomy refers to an individual's capacity to regulate and steer their own learning process and involves the ability to decide what, when and how to learn, along with having a chance to reflect on and adjust those decisions. It is a valuable aspect of motor learning as it enables individuals to tailor their learning to their own needs and interests. Consequently, autonomy can enhance motivation and involvement, thus leading to better learning results. Autonomy as it relates to motivation has been shown to have a robust effect across tasks in several studies (Wulf, 2013; Janelle & Hillman, 2003; Wulf & Su, 2007; Halperin et al., 2018; see Wulf & Lewthwaite, 2016, for review). Autonomy in motor learning can involve learners choosing the type of practice they want (e.g., blocked or random); allowing them to set their own goals and providing opportunities for self-assessment.

Research on motor learning has already shown positive associations between motor learning and autonomy (Wulf & Lewthwaite, 2016; Lewthwaite et al., 2015; Ikudome et al. 2019). Autonomy support was shown to facilitate motor learning of a novel motor skill (e.g., 24 adult participants throwing a ball with their non-dominant hand) when participants were given an incidental choice in ball color (Lewthwaite et al., 2015). The results revealed higher accuracy making a basket when given autonomy support than in the control group, supporting the theory that offering learners a small choice, even one unrelated to the task goal or movement itself has an independent influence on learning (Lewthwaite et al., 2015).

In a study examining the effect of choice in nonspeech motor learning for learners with varying levels of intrinsic motivation, two experiments were conducted with adult participants without a reported impairment. In Experiment 1, participants were divided into four groups: High Motivation/Choice, High Motivation/No Choice, Low Motivation/Choice and Low Motivation/No Choice. In order to measure intrinsic motivation, the researchers directed participants to a waiting room before the experiment began. The participants were told there was an instructional video they could watch while they were waiting, The researchers then observed whether or not they watched the video and for how long to distinguish high and low motivation participants For the main task, participants selected dart color for a dart-throwing task (Ikudome et al., 2019). During the pretest and retention test, all participants used a yellow dart. During the Practice phase, the Choice groups chose their dart color while participants in the No Choice group's dart color was yoked to a participant in the Choice group. A learning benefit of task-irrelevant choice (vs. no choice) was observed for the low motivation groups, but not for the high motivation groups (Ikudome et al., 2019). Importantly, the authors of the study noted that the participants in the Choice group were given only one opportunity to choose their dart-color during the practice phase. Giving learners multiple opportunities for choice (e.g., offering a choice of dart color at each trial) could have augmented the results of this experiment (Ikudome et al., 2019).

The second experiment was the same as the first, except that the choice was considered task relevant. All participants watched a one-minute instructional video, but the Choice group was allowed to select when they wanted to watch the video during the practice phase. The No Choice group watched the video at a time yoked to a participant in the Choice group's selected time. All participants used a yellow dart. In this experiment, Ikudome et al. found that making choices that are relevant to the task had a positive effect on motor learning to the same extent regardless of initial motivation levels. Both experiments demonstrate that participants who were given some autonomy experienced greater learning compared to those who were not given autonomy, regardless of whether the choices were task-relevant (e.g., preferred video watching time) or task-irrelevant (e.g., dart color). However, this autonomy effect was absent for highly motivated participants in the case of task-irrelevant choice. Thus, for task-relevant choices, autonomy enhances learning regardless of initial motivation. Regarding motor performance in children, Abdollahipour et al. (2017) examined how autonomy support could enhance children's motor performance. Using a within-participant design and a bowling task, they demonstrated that autonomy support (through choice among bowling balls) independently contributed to increased motor performance. In summary, these experiments underscore the consistent efficacy of autonomy in enhancing motor learning across various tasks and contexts, suggesting a broader applicability of autonomy's facilitative role in skill acquisition beyond the domains examined in this study.

Autonomy in the Speech Literature

The effect of autonomy has not been studied specifically in the realm of speech. However, there is evidence to support that self-determination is important in speech therapy. One study on the therapist-client relationship in speech-language treatment, using self-determination theory (SDT; Deci & Ryan, 2008), assessed the observed and perceived amount of control and motivation in three groups: adults (>18 years old), adolescents (12-18 years) and children (<12 years) with communication disorders (Haerens et al., 2021; Deci & Ryan, 2008). SDT is a theory of human motivation that identifies three core psychological needs in people, one of which is autonomy. Core needs are necessary for people’s motivation and development, while not having them met “hampers optimal motivation, growth and development” (pg. 2, Haerens et al., 2021). Regarding intrinsic motivation, specifically, Deci and Ryan found that it is the most ideal form of motivation. It is plausible to assume that autonomy of choice enhances intrinsic motivation.

The two sources of data for analysis included observations from treatment sessions and client-completed questionnaires after treatment. During treatment, the speech-language pathologist (SLP) offered the client opportunity to take initiative (i.e., asking a child what color pencil they would like to use). Two graduate speech, language and hearing science students performed the observations. The clients then completed a 55-item questionnaire, with assistance from the graduate students, without the presence of the treating SLP. Haerens et al. found that autonomy supportive interactions enhanced intrinsic motivation and clients reported less frustration than interactions involving a "controlling style" (i.e., demotivating) and "pressuring behaviors" that value the clinician's point of view over the client's (pg. 3, Haerens et al., 2021). These results were true across age groups, but more significant in children under the age of 12 years based on self-report.

Ultimately, the demonstrated importance of autonomy-supportive interactions in speech-language therapy, particularly in enhancing intrinsic motivation and reducing frustration across various age groups, could lay a solid foundation for exploring its potential impact on speech motor learning in children with CAS. The following section will detail the methodology utilized in this study to examine how autonomy influences speech motor learning outcomes in this specific population.

The Present Study

This study employed an alternating treatments single-case experimental design to compare child-directed and clinician-directed choice in a child with CAS. The study used an integral stimulation-based treatment approach where individualized target words and/or phrases are practiced with different prosodic variations such as happy, angry, and sad. During the Child-Choice (Autonomy) condition, the child was given the freedom to choose the prosodic variation they wanted to use for practice, while in the Clinician-Choice (Non-Autonomy) condition, the clinician selected the prosodic variation. The primary outcome measure was speech accuracy of the targets as produced on imitation probes. Additionally, untreated control items were included to replicate the overall effect of the treatment approach, regardless of autonomy.

The role of autonomy has been examined predominantly in nonspeech motor learning research, and to the best of our knowledge there has been no systematic research conducted on autonomy in speech. While research has demonstrated a robust relationship between autonomy and motor learning (Wulf & Lewthwaite, 2016) it remains to be seen if the same is true when the theory is extended to motor speech treatment for children with CAS. Rather than making a radical change to current CAS treatment, this study will look at how seemingly small task-relevant choices could impact the effectiveness of speech therapy for children with CAS. Since there is some evidence that choice, especially task-related choice, is relevant to motor learning outcomes, we may see an effect. Though some aspects of PML have been shown to be applicable for both speech and nonspeech motor learning, that does not necessarily mean that everything that is good for one type of motor learning is good for the other.

This research could contribute information to decisions on whether to use client-directed choice or to use clinician-directed choice. In studying the role of autonomy as it relates to CAS treatment, we sought to answer whether autonomy, through the mechanism of client-directed choice, impacted their motor learning. The primary research question was whether client-directed choice enhances learning compared to clinician-directed choice. If client autonomy was given during treatment, it could lead to better motor learning outcomes. Alternatively, increasing the level of client autonomy could have had potential drawbacks. For one, there are emotional and psychological factors (e.g., stress, self-efficacy, motivation levels) that cause some individuals to experience negative effects from increased autonomy (Wulf & Lewthwaite, 2016). Additionally, SLPs often use clinical expertise to make individualized treatment decisions; increased client autonomy necessitates a drop in clinician-directed decision-making and could limit flexibility (Gomez et al., 2022; Lancaster et al., 2010). For these reasons, it could be argued that it is better to rely on clinical expertise than to leave those decisions up to the client, particularly in the case of pediatric clients. Accordingly, we propose two hypotheses:

- Autonomy leads to greater learning than non-autonomy.
- Non-autonomy leads to greater learning than autonomy.

CHAPTER 2

METHODS

Participant: Jaiden

Jaiden (a pseudonym) was 4 years and 11 months old at time of enrollment and from a monolingual English-speaking home and Pre-K educational setting, based on parent report. He lived at home with his mother and father, had no siblings, and one dog.

Inclusion/Exclusion Criteria. Inclusionary criteria included the presence of a speech sound disorder, as indicated by a standard score of 90 or lower on the Goldman-Fristoe Test of Articulation, 3rd edition (GFTA-3; Goldman & Fristoe, 2016) and/or clinical judgment; an Apraxia Score of 1 or 2 classification (indicating CAS) on the maximal performance protocol (MPT; Thoonen et al., 1999); and the diagnosis of possible or definite CAS by an experienced SLP. This diagnosis was based on the perceived presence of key CAS characteristics. Among these characteristics were inconsistent vowel and/or consonant errors upon repetition, difficulties transitioning between articulatory placements, and abnormal prosody. The participant needed to have adequate oral structure and function, based on an oral mechanism examination; had to have normal hearing based on parent report or passed a hearing screening at 500, 1000, 2000, and 4000 Hz at 25 dB (ASHA, 1997); and normal or corrected-to-normal vision, based on parent report. Exclusionary criteria included a native language other than English, a diagnosis of a neurobehavioral disorder that might significantly impact speech, language, and communication abilities (e.g., Down syndrome), a parent report suggesting uncorrected vision or hearing deficits, significant impairment of the oral mechanism determined through an oral motor examination (e.g., cleft palate), significant dysarthria, or unrelated health concerns that would prevent the child from participating.

Table 1

Participant Information & Preliminary Evaluation Results

Participant Information	**Jaiden**
Age	4;11
Gender	M
GFTA-3	
Standard Score	41
Percentile Rank	<0.1%
DEAP	
Items Produced Differently (D)	11
Items Repeated 3 Times (S+D)	25
Word Inconsistency Score (D/(S+D))	44%
EVT-2	
Standard Score	83
Percentile Rank	13
PPVT-4	
Standard Score	69
Percentile Rank	2
RIAS	
Nonverbal Intelligence Index T-Score	35
Nonverbal Intelligence Index Percentile Rank	13
DEMSS	
Vowel Accuracy	69/120
Prosodic Accuracy	6/24
Overall Articulatory Accuracy	127/240
Consistency	18/42
DEMSS Overall Total Score	220/426

Formal and informal assessments were administered to evaluate Jaiden's communication skills and determine eligibility (see Table 1). The GFTA-3 (Goldman & Fristoe, 2016) was used to ascertain the accuracy of articulation for high-frequency English phonemes; the Diagnostic Evaluation of Articulation and Phonology (DEAP; Dodd, Hua, Crosbie, Holm, & Ozanne, 2006) assessed phonological processes and misarticulations across words; the Expressive Vocabulary Test, 2nd edition (EVT-2; Williams, 2007) evaluated language abilities specific to expressive vocabulary and word-finding; the Peabody Picture Vocabulary Test, 4th edition (PPVT-4; Dunn & Dunn, 2007) explored receptive vocabulary; finally, nonverbal sections of the Reynolds Intellectual Assessment Scales (RIAS; Reynolds & Kamphaus, 2003) were administered. Additionally, the Dynamic Evaluation of Motor Speech Skills (DEMSS; Strand & McCauley, 2019) was used to evaluate accuracy and consistency of speech movements; the Maximum Performance Protocol (MaxPT; Rvachew, Hodge, & Ohberg, 2005; Thoonen et al., 1996, 1999) to quantify and differentiate symptoms associated with dysarthria and CAS during syllable repetition and prolongation tasks; and an oral mechanism examination was administered. Additionally, a conversational speech sample was elicited.

Design

This study used a single-case experimental design, specifically an alternating treatments design with a single phase (Kearns, 1986) and untreated control behaviors. Two conditions (Clinician-choice and Child-choice) were compared. The treatment study included the baseline phase, which lasted 3 weeks, followed by a 4-week treatment phase. After the treatment phase, there was a maintenance phase, lasting for 2 weeks (See Table 2). The treatment phase consisted of two sessions per week, each lasting one hour. Sessions were planned to be divided into two halves of 25 minutes (one per condition), with a 5-minute break in between. The first session of the treatment phase began with the Child-choice condition, with alternating order after that. The reason for starting with the Child-choice condition was to enable the clinician to gauge the child's preferences for prosodic variations so that the clinician could attempt to match the proportions of different prosodic variations in the Clinician-choice condition. In this way, we aimed to minimize differences between conditions with respect to the prosodic variations used themselves, and thus isolated the effect of autonomy (similar to the “yoked” groups in the motor learning literature; Wulf & Lewthwaite, 2016). The reason for alternating condition order in subsequent sessions was to ensure that an equal number of sessions started with each condition to minimize systematic effects of fatigue, etc. In each treatment phase, a distinct set of targets was treated in each condition, and an untreated control set of items was included in all probes to provide a control for maturation, repeated testing effects, etc. (see Target Selection below). This enabled examination of the effect of the treatment regardless of choice condition.

Table 2

Present Study Timeline

Weeks 1-4	**Weeks 5-9**	**Weeks 10-12**
Testing & Baseline	Treatment phase	Maintenance phase
4-10 sessions	2 sessions/wk	1 session/wk

Target Selection. Targets were individualized and consisted of words and/or phrases that were functionally relevant and meaningful to the child. We solicited potential targets via a structured caregiver questionnaire (Wilson & Gildersleeve-Neumann, 2014). From the items on this questionnaire, we selected words and/or phrases that contained sounds that were in the child’s phonetic inventory and that consisted of syllable shapes in the child’s phonotactic inventory. A list of potential items was administered during the assessment phase using a delayed imitation task. Based on the child’s accuracy (e.g., excluding items that the child already produced correctly), 24 items were selected from the list to create 4 sets of 6 items. Sets were matched as much as possible for the length of targets (number of syllables and words), complexity of targets (Index of Phonetic Complexity; Jakielski, 2017), word type (e.g., social phrase; friend/sibling name), and personal relevance. After matching the four sets, they were randomly allocated to conditions (Child-choice phase 1, Clinician-choice phase 1, 2 control sets) to eliminate potential bias in target selection. Items sets are presented in Table 3.

Table 3

Target sets.

Clinician-choice set	**S**	**W**	**IPC**	**Child-choice set**	**S**	**W**	**IPC**
I need you	3	3	2	**Natalie**	3	1	2
potty	2	1	1	TV	2	1	2
Play-Doh	2	1	3	shoes	1	1	3
underpants	3	1	6	cookies	2	1	5
What's that?	2	2	4	Which one?	2	2	4
cousins	2	1	6	target	2	1	5
mean	***2.33***	***1.50***	***3.67***	***mean***	***2.00***	***1.17***	***3.50***
SD	*0.52*	*0.84*	*2.07*	*SD*	*0.63*	*0.41*	*1.38*
Control set 1	**S**	**W**	**IPC**	**Control set 2**	**S**	**W**	**IPC**
one minute	3	2	4	boots	1	1	3
snack time	2	2	5	stop	1	1	3
iPad	2	1	2	bagel	2	1	5
McDonalds	3	1	7	vacation	3	1	6
Why not?	2	2	2	magic	2	1	5
bath	1	1	3	**I'm done**	2	2	3
mean	***2.17***	***1.50***	***3.83***	***mean***	***1.83***	***1.17***	***4.17***
SD	*0.75*	*0.55*	*1.94*	*SD*	*0.75*	*0.41*	*1.33*

Note. Bold items are considered 'high priority' items by the family. S = number of syllables; W = number of words; IPC = Index of Phonetic Complexity (Jakielski, 2016). All sets were matched (all p-values > 0.20).

Procedures

Probe Procedures. The primary outcome measure (speech accuracy) was based on performance on a probe task conducted throughout the study (from baseline to follow-up). The probe task involved an imitation task, in which the treating clinician presented each item live, in a neutral prosody, for the child to repeat immediately. All 24 items were included on the list, and these were presented in a different random order each time. The child did not receive feedback on accuracy, but general encouragement was provided (e.g., “You’re working so hard”). The clinician presented the model only once, except in cases of background noise or overtalk, or when the child did not hear the model or explicitly requested a repetition. The child was encouraged to pay attention, listen carefully, and repeat the model on the first attempt. Probes were administered twice per week during baseline and treatment phases and once per week during maintenance phase. During the treatment phase, probes were administered at the beginning of the session in order to capture short-term retention of gains from previous sessions rather than temporary performance boosts from having just completed a treatment session. All sessions were audio- and video-recorded for analysis.

Treatment Procedures. The treatment was ASSIST (Apraxia of Speech Systematic Integral Stimulation Treatment; Maas et al., 2022), a structured integral stimulation-based approach that incorporates principles of motor learning. Two minor changes to the original protocol were made for the purpose of this study. First, in standard ASSIST, target words or phrases are practiced in different frames (carrier phrases) to implement variable practice and facilitate experience with prosody (e.g., target *puppy* might be practiced in *Bye, puppy; Go, puppy; Puppy did it*). For the purposes of this study, we only focused on targets, rather than carrier phrases. Second, elicitation of targets during practice did not include direct imitation with constant prosody, because the manipulation of interest here (autonomy of choice) was applied to variable prosody (either child or clinician chooses which prosody to use).

Any given 25-minute session (condition) included no more than four targets, to maximize the amount of practice that each target received. Specific performance criteria determined whether and when a new target was introduced. Treatment started with the four targets with medium phonetic complexity: when ranked by IPC, the items with the lowest and highest values were probed but not entered into treatment unless and until criteria were met to introduce them (in case of IPC ties, items were randomly selected from among the ties). The items with the lowest and highest IPC served as “step-down” and “step-up” items depending on the child’s performance.

Sessions were divided into pre-practice and practice components. Pre-practice was intended to motivate and prepare the child for the learning opportunities to be provided during the practice component, by explaining the purpose of the activities to follow and showing that the targets were within the child’s reach, even if with maximal support. This involved eliciting the targets in small blocks of five consecutive attempts until each target was produced correctly or a total of 15 minutes has elapsed. The small blocks were presented in random order. Pre-practice is structured along principles of motor learning that are thought to enhance performance (acquisition), including constant practice, blocked practice, 100% feedback, and knowledge of results and knowledge of performance feedback. The clinician was free to use cues or supports of her choosing to establish the motor pattern.

After a 1-minute break, practice started. Practice involved brief, 4-minute bursts of repeated practice (called ‘practice runs’) during which the clinician elicited as many teaching episodes as possible. Teaching episodes are structured sequences of events that involve brief dynamic shaping efforts according to the test-teach-retest model. Specifically, the teaching episode started with elicitation of the target with one of three elicitation methods (direct imitation, delayed imitation, and independent production), depending on the child’s performance on previous teaching episodes involving that target; the first teaching episode used direct imitation, and the elicitation method systematically moved toward delayed imitation and independent production depending on the child’s performance (see decision flowcharts in Appendix A). Following the child’s first response, the clinician gave feedback (knowledge of results only) and, if incorrect, provided cues and support to shape and elicit up to two more attempts, with feedback, after which the clinician elicited the target one more time, using the same elicitation method as the first attempt, to close out the teaching episode. If the child’s response to the first elicitation was correct, the clinician provided feedback and then elicited one more attempt using the next-level elicitation method (stepping up difficulty level after success). The child received a 1-minute fun break after each 4-minute practice run. Practice was structured along principles of motor learning thought to enhance learning (retention and transfer), including random practice, variable practice, knowledge of results feedback only, provided with a short (2-3 second) delay and on a fading schedule (i.e., not 100% feedback).

For the purpose of this study, variable prosody included three different variations (happy, sad, angry). In each practice run, Jaiden was instructed that each prosodic variation must be used at least once. In the child-choice condition, Jaiden chose the prosody before each teaching episode. In the Clinician-choice condition, the treating clinician told the child which prosody would be used prior to each teaching episode. Visuals were presented to represent each prosody so that Jaiden could point to it. All sessions were audio- and video-recorded for later analysis.

Data Analysis

Outcome Data. The primary outcome measure was speech accuracy, as judged by four trained blinded listeners from audio recordings using a 3-point scoring system (Jing & Grigos, 2022; Maas & Farinella, 2012; Strand et al., 2006). In this scoring system, a score of 2 represented a correct production, a score of 1 represented a minor error (e.g., vowel or consonant distortion, single-feature consonant change), and 0 represented a major error and/or multiple errors (see Appendix B for detailed scoring protocol).

Before scoring the data, raters calibrated their scoring on speech recordings from three different children with CAS (who were not part of the preset study) and achieved >80% agreement with each other and a prior score by a trained rater. Reliability among all four raters and for each rater pair was evaluated via intra-class correlations (ICC) (single-rater two-way random effects model for absolute agreement; Hallgren, 2012; Koo & Li, 2016). ICC takes agreement-by-chance into account, and values range from -1 (complete disagreement) to +1 (complete agreement), with a value of 0 indicating chance (random) agreement. Common interpretations (Hallgren, 2012) are poor (ICC < 0.40), fair (ICC < 0.59), good (ICC < 0.74), and excellent (ICC > 0.75).

ICC among all four raters was fair (ICC= 0.529; 95% confidence interval [CI]: 0.459 - 0.597), as were most pairwise ICCs (see Table 4). Because ICCs were mostly in the fair range, percentage agreement on point-to-point basis and within 1 scale point were also examined (see Table 5). Mean point-to-point agreement across all pairwise comparisons among raters was high (>80% in all cases), with virtually all disagreements involving a single point difference (i.e., 0 vs. 1 or 1 vs. 2 scores): within-1-scale-point agreement ranged from 99% to 100%.

Given that ICCs were in the fair range, outcome data were based on the mean score across the four raters' means per target set. Mean scores were divided by 2 to create a percentage accuracy (because the maximum on the scale is 2).

Table 4

Pairwise inter-rater reliability data ICC [95% confidence intervals] among raters.

Rater	**1**	**2**	**3**	**4**	**Mean**
1		0.561 (fair) [0.46 – 0.647]	0.484 (fair) [0.363 – 0.587]	0.497 (fair) [0.387 – 0.592]	**0.514 (fair)**
2	0.561 (fair) [0.46 – 0.647]		0.497 (fair) [0.366 – 0.605]	0.509 (fair) [0.398 – 0.604]	**0.522 (fair)**
3	0.484 (fair) [0.363 – 0.587]	0.497 (fair) [0.366 – 0.605]		0.614 (good) [0.522 – 0.692]	**0.532 (fair)**
4	0.497 (fair) [0.387 – 0.592]	0.509 (fair) [0.398 – 0.604]	0.614 (good) [0.522 – 0.692]		**0.540 (fair)**

Table 5

Pairwise agreement among raters: Point-to-point agreement (top number in cell) and within-1-scale-point agreement (bottom number in cell).

Rater	**1**	**2**	**3**	**4**	**Mean**
1		89.5% 100.0%	80.4% 99.5%	84.2% 99.0%	**84.7%** **99.5%**
2	89.5% 100.0%		81.3% 99.5%	83.7% 99.5%	**84.8%** **99.7%**
3	80.4% 99.5%	81.3% 99.5%		80.4% 100.0%	**80.7%** **99.7%**
4	84.2% 99.0%	83.7% 99.5%	80.4% 100.0%		**82.8%** **99.5%**

Data Analysis Plan. Speech accuracy data was plotted for visual inspection. Visual inspection was supplemented by effect sizes and raw percent change. Effect sizes were computed according to the formula d = ((mean post-treatment – mean pre-treatment) / SD pre-treatment) x 100 (Beeson & Robey, 2006; Busk & Serlin, 1992). Effect sizes were computed for each condition separately. Effect sizes were compared between conditions to address the primary research question (Does client-directed choice enhance learning compared to clinician-directed choice?). Comparison between treated item sets and untreated item sets further provided a replication of the overall ASSIST protocol. Following earlier work, we considered effect sizes > 1 to indicate a significant effect (e.g., Behrman, 2014; Maas & Farinella, 2012; McAllister et al., 2016).

CHAPTER 3

RESULTS

Context: Study Implementation

Before delving into the primary outcome results, deviations, challenges, and an overview of treatment as implemented are addressed (See Table 6.)

Table 6

Time spent in treatment vs. managing behaviors/incentivizing client's participation.

Session	Phase	Time Spent	Condition
1	Data Collection Probe	6:00	**-**
	Prepractice 1	15:00	**Child-choice**
	Practice 1	4:00	**Child-choice**
	Managing Behaviors/Incentivizing	16:00	**Child-choice**
2	Data Collection Probe	8:00	**-**
	Prepractice 1	15:00	**Clinician-choice**
	Practice 1	4:00	**Clinician-choice**
	Prepractice 2	15:00	**Client- Choice**
	Practice 2	4:00	**Child-choice**
	Managing Behaviors/Incentivizing	22:00	**Child-choice**
3	Data Collection Probe	3:00	**-**
	Prepractice 1	15:00	**Child-choice**
	Practice 1	8:00	**Child-choice**
	Managing Behaviors/Incentivizing	19:00	**Child-choice**
4*	No Session		
5	Data Collection Probe	6:18	**-**
	Prepractice 1	15:00	**Clinician-choice**
	Practice 1	4:00	**Clinician-choice**
	Managing Behaviors/Incentivizing	15:42	**Clinician-choice**
6	Data Collection Probe	2:30	
	Prepractice 1	15:00	**Clinician-choice**
	Practice 1	4:00	**Clinician-choice**
	Managing Behaviors/Incentivizing	25:30	**Child-choice**

It is essential to note that our results are preliminary as we do not yet have maintenance data due to several unexpected absences which delayed onset of treatment.

The data reported here reflects results up to Treatment Session 7 (Probe 6). Of the planned sessions, two were missed (Treatment sessions 4 and 8). Additionally, not every session unfolded as expected, which required careful adaptation. Many sessions ended before both conditions could be utilized; however, because we counterbalanced sessions as much as possible, approximately equal amount of practice time was spent in both conditions (~80 minutes in Clinician-choice, ~80 minutes in Child-choice), though with more completed teaching episodes in the Child-choice condition (see Table 7).

Table 7

Frustration Scores and Teaching Episodes by condition.

B4B 012	**Clinician-choice**		**Child-choice**	
	# of teaching episodes	**frustration**	**# of teaching episodes**	**frustration**
Session 1	-	-	3	3
Session 2	4	2	4	3
Session 3	-	-	16	1
Session 4	3	1	-	-
Session 5	1	3	-	-
Session 6	2	2	2	2
	Total = 10	Mean = 2.0	Total = 25	Mean = 2.25

Note. Frustration scores are provided by the clinician at the end of each session half, using a 4-point scale to judge the child's frustration level as perceived by the clinician (0 = no frustration, full compliance; 1 = mild frustration, occasional non-compliance; 2 = significant frustration, frequent non-compliance; 3 = marked frustration, non-compliant entire session) (Maas, Cook, Alper, & Caspari, 2024).

Primary Outcomes

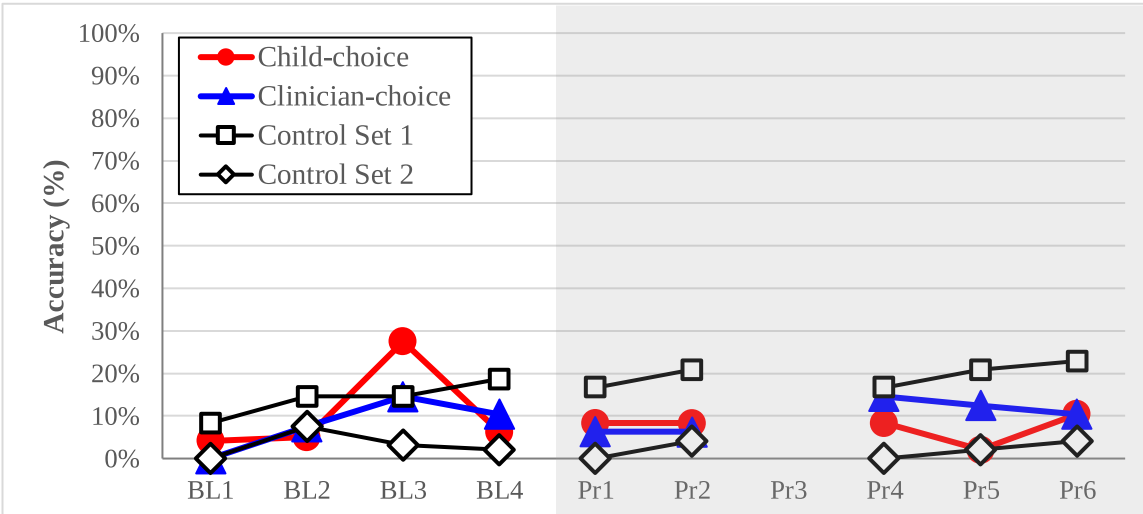
For the primary outcome measure (see Figure 1), we determined effect sizes using the last probe point (Probe 6), using the same formula but with Probe 6 instead of post-treatment data. We observed relatively stable performance across four baseline points. Although there was a gradual increase over the first three data points for some of the sets, accuracy declined for the treated sets before treatment initiation at Baseline 4. Control Set

1 exhibited slightly higher values, potentially continuing a trend observed in the baselines. Thus, with the exception of Control Set 1, there were no consistent upward trends leading into treatment. In addition, there were no major differences between the sets (e.g., within the 0-20% range), indicating well-matched conditions (mean accuracy across the four baseline sessions: Child-choice = 11%; Clinician-choice = 8%; Control 1 = 14%; Control 2 = 3%).

The treatment phase did not reveal any clear improvements for any of the sets. For the treated sets, none of the probes during the treatment phase exceeded the highest score obtained during baseline. Further, although there appeared to be a marginal advantage favoring the Clinician-choice condition in later sessions (Probes 4 & 5), this difference was not substantial and not evident at Probe 6. When comparing Probe 6 to baseline, neither treated set demonstrated significant effect size and negligible change (Child-choice: $d = -0.03$, -0.3% change; Clinician-choice: $d = 0.37$, 2.3% change). Control Set 1 did demonstrate a significant effect size ($d = 2.06$, 8.9% change), which appeared to maintain a steady level from the last baseline point; Control Set 2 did not show appreciable change ($d = 0.31$, 1% change). No clear differences were observed within or between treatment conditions or between treated and untreated sets.

Figure 1

Primary outcome data.



Note. Shaded area indicates treatment phase Probe 3 session [Treatment Session 4] was missed due to illness).

CHAPTER 4

DISCUSSION

This study sought to examine whether autonomy enhances speech motor learning, using the ASSIST protocol, in children with CAS. In a single-case alternating treatments design, we examined two conditions: in one condition, the child was offered the choice of practice intonation (happy, angry, sad), and in the other, the treating clinician chose the practice intonation (happy, angry, sad). A secondary goal was to replicate the effect of ASSIST (vs. no treatment) by comparing treated sets to untreated sets. The outcome measure was perceptual accuracy as determined by four blinded raters using a 3-point scoring system. Findings are preliminary in that post-treatment data are not yet available at this time. Results to date reveal no clear effects for either autonomy or for treated vs. untreated sets. Below, we discuss several possible reasons for this lack of effects.

One obvious possible reason is that the study has not yet concluded. The child therefore may not have received a sufficient amount of treatment for effects to emerge. It should be noted that this study involved only a single phase of 4 weeks, with a planned total of 8 treatment sessions. This amount of practice is low compared to previous studies (e.g., Grigos et al., 2023; Maas et al., 2012, 2019; Strand et al., 2006), and previous work has suggested the importance of a high amount of practice (e.g., Edeal & Gildersleeve-Neumann, 2011; Maas et al., 2019; Namasivayam et al., 2015). For example, Maas et al. (2019) noted that after their first 4-week treatment phase, significant effects (averaged across 6 children) were observed only with a high amount of practice (~4-5 teaching episodes per session vs. ~2 teaching episodes for low amount). The practice amount in this study was closer to the low-amount condition in Maas et al. (2019). In addition, the child missed one of the treatment sessions, further reducing practice amount.

The relatively low number of teaching episodes completed was due in part to challenges with attending and the resulting need for redirection and behavior management. This could be attributed to the young age of the participant. Young children with CAS may not consistently attend to cues, which are integral components of pre-practice, thereby limiting the impact of autonomy-supportive interactions on motor learning. Further, children with CAS may attempt to avoid speech tasks that are difficult for them. The participant's scores on the Frustration Scale taken at the end of each practice run reveal consistently moderate-high levels (e.g., scores of mostly 2 or 3) of distractibility and need for redirection (see Table 6). Thus, these challenges may have impacted the quantity and quality of treatment sessions.

Nevertheless, our study demonstrates the reality of working with pre-school age children and can offer valuable insights into the complexities inherent in working with this population. These considerations show the importance of taking developmental factors and individual differences into account when examining the influence of autonomy in this population. Treatment in a routine clinical environment can allow for a level of flexibility that is difficult to replicate in a research environment using a protocolized treatment, and that flexibility may be beneficial for young children. Future research endeavors may benefit from incorporating strategies to enhance cue responsiveness and investigating alternative approaches to promote motor learning in children with CAS, as well as extending this line of research to older children with CAS.

With respect to autonomy condition differences specifically, anecdotally, Jaiden often expressed a desire to choose the prosodic variation during the Clinician-choice condition (e.g., usually several times per practice run), suggesting that he did prefer to have autonomy of choice. All else being equal (e.g., if no differences in speech accuracy outcomes), this would support the practice of offering children autonomy during treatment.

Future research should also consider other possible ways to manipulate autonomy. In the present study, we chose to vary practice intonation (an element of ASSIST to increase practice variability) and allowing either the child or the clinician to select the intonation. However, the participant demonstrated a strong preference for choosing the ‘happy’ intonation (despite instructions to use each prosodic variation at least once per practice run), thereby reducing practice variability. This observation underscores the significance of choice within the study, highlighting the participant's autonomy in selecting his preferred intonation. Because the clinician attempted to match the child’s choices to avoid confounds with regard to intonation and practice variability, it is possible that this reduced variability is in part responsible for the lack of overall treatment effects. Future studies could implement different intonation types (e.g., question vs. statement), or the order in which targets are practiced, or location of practice (e.g., on the floor, in a chair at the table).

This study sheds light on some dynamics between autonomy and speech motor learning among children with CAS. While initial results did not yet provide conclusive evidence for the efficacy of autonomy, anecdotal observations suggest a propensity towards autonomy preference in the participant. The challenges experienced during this study show the importance of tailored interventions and flexibility in clinical practice. By using a flexible and personalized approach, we can better serve the diverse needs of children with CAS and grow our understanding and effectiveness in clinical intervention.

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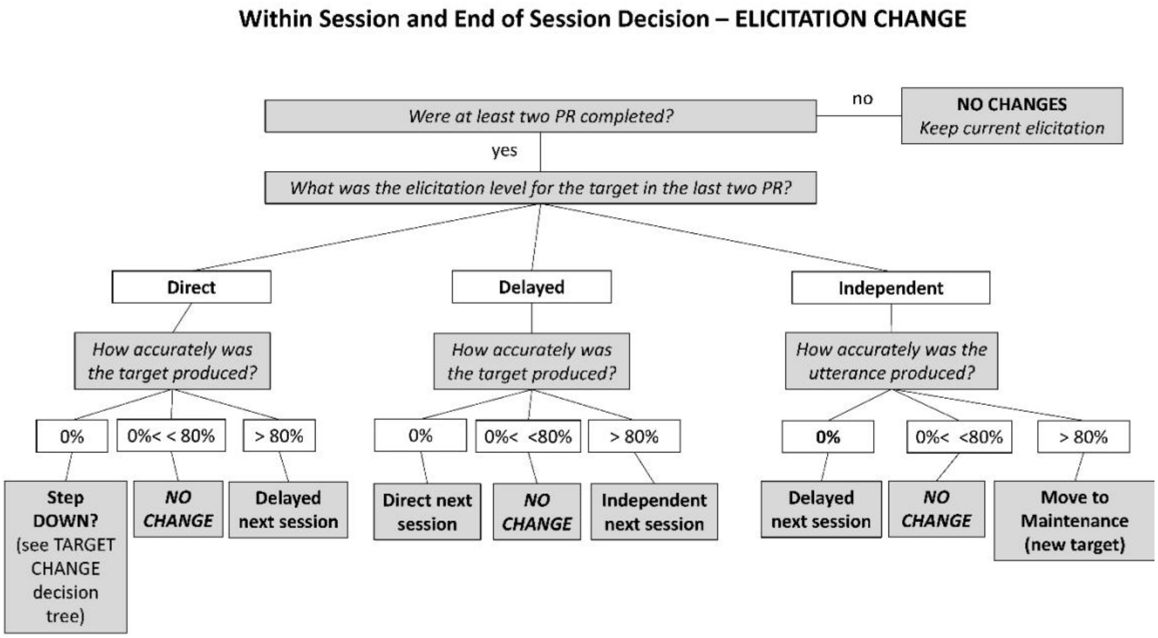
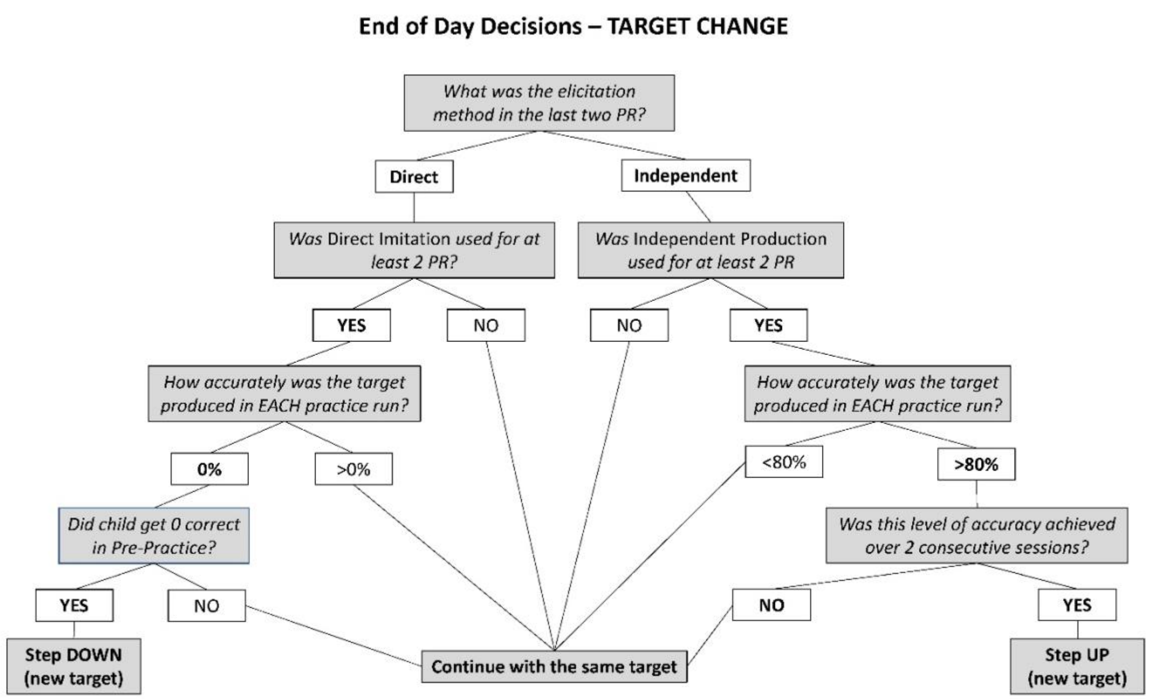
APPENDIX A

DECISION FLOWCHARTS





APPENDIX B

DATA SCORING INSTRUCTIONS

DATA SCORING INSTRUCTIONS

The task is to score the accuracy of productions of treated and untreated items (words and/or phrases; 24 total). The child repeats these items after the clinician multiple times before, during, and after the treatment phase. The accuracy scores of these productions constitute the primary data to determine whether the treatment has an effect, and whether one condition leads to greater improvement than another. This scoring must be done blinded – blinded to time point (when the recording was made: before, during, or after treatment phase), and blinded to item status (whether a particular item is a treated or untreated item).

Getting Started

1. **Entering scores:** Enter your scores directly in the Excel spreadsheet, which should have your first name and last initial added at the end. For example, the file would be named B4B-CAS-012_scoresheet_EdwinM.xlsx for me. Each file has multiple tabsheets, labeled 1-14. These labels correspond to the audio files to be scored.

2. For scoring probe data, we will **use the audiofiles**, because the sound quality is better than that of the video (there are separate recording devices). I recommend that you copy the sound file to your local lab workstation (on the desktop), so that you can use a playback program that allows you to scroll with precision (the autoplay on Teams is less useful for that).

a. **NOTE:** You can play the audiofiles with several programs, including Windows Media Player, TF32, Adobe Audition, Praat, etc.. I recommend either TF32, Praat, or Adobe Audition, because these show the waveform and you can zoom in on a portion, which makes it easier to pause and go back to a specific word to listen to it again. In many cases, you will need/want to listen to each word more than once.

- If using TF32 or Praat, you may need to install it first. For TF32, this simply involves copying the TF32.exe file from Teams to your local desktop. For Praat, you may need to download it from www.praat.org and install it from your local desktop. Please let Teodora or me know if you have any questions or difficulties with this.

b. **NOTE:** TF32 does not have sound editing capability, so you cannot accidentally delete portions of the sound file, although you can accidentally record over it if you hit the Record button. *Don't hit the Record button*. Adobe Audition does have editing capability so you could accidentally change the sound file, but it may be more user-friendly than TF32. And if you are working with a copy of the original sound file (as you should), then there is no problem.

3. **Always use headphones** to do the scoring. There are 3 main reasons for this: (i) It increases the accuracy of your scores, because it reduces outside noise and distractions for you as a scorer, (ii) it reduces distraction for others nearby, and (iii) it minimizes potential HIPAA/privacy breaches (sound files played over speakers can be overheard by people who have no need to know).

4. **Score the speech sample** using the 3-way scoring system (further detail below):

5. **Write down notes** for any item that receives a score of 0 or 1 to indicate the reason for the reduced score (e.g., vowel distortion, segmented speech, self-correction, consonant substitution, etc.). Enter these notes in a separate column in the spreadsheet. These notes will help us understand the nature of the child's speech difficulties, as well as resolve any potential discrepancies between scorers.

6. It is **VERY IMPORTANT** that you **score independently**, without consulting with others. Don't look at someone else's scoresheets. If you have any questions, please ask me and we can discuss.

7. The **time involved** in scoring a single session will vary depending on the child, your auditory perceptual abilities, and your degree of thoroughness. Sessions will typically be about 5-10 minutes in audio-file time, which on average will come out to be somewhere around 30 minutes to score. I suspect that with practice and increasing familiarity with the scoring system, you will eventually be at an average of about 15-20 minutes per session.

<u>THE 3-way SCORING SYSTEM</u>

The scoring system described below is adapted from Strand et al. (2006), and was also used in Maas et al. (2012) and Maas and Farinella (2012). NOTE that we judge ***accuracy*** (not *intelligibility*) of the child's production. The scoring system has 3 levels:

2 = correct response

1 = response has minor error

0 = incorrect response, involving more than a minor error

More details and specific examples about each score classification are provided below, but basically

a score of 1 is reserved for productions that are close but not entirely correct. Anything more than a

minor error gets a 0.

<u>Score of 2 (correct):</u>

Production must have **no errors, must be fluent**, and generally must sound natural or normal to you.

- *Errors* include omissions, additions, substitutions, distortions (including excessive lengthening), incorrect stress patterns, sound or syllable segmentation ("choppy" speech), unintelligible utterances, etc.
- *Self-corrections* are also considered (minor) errors, because they indicate that the child was not able to produce a correct response on the first attempt. So even if a child self-corrects to a "correct" response this would still not be a 2 but instead would be a 1 (assuming no other errors, normally fluent response, etc.).

<u>Score of 1 (minor error):</u>

Production must contain **no more than one** "**minor error** (e.g., one distinctive feature off consonant production, or close approximation of movement gesture, or only one mild vowel distortion" (Strand et al., 2006: 301). In other words, a score of 1 represents a close approximation of the target. Minor errors can be segmental or suprasegmental.

- *Segmental*: Vowel and consonant distortions (including excessive lengthening) or consonant substitutions involving a difference of no more than a single phonetic feature (place of articulation, manner of articulation, or voicing). Distortions are defined as sounds that are recognizable as the target sound but that are not clear, well-articulated examples of that target sound. Distortions may sound like a sound between the target and some other sound (e.g., a vowel halfway between /æ/ and /ɛ/, a consonant halfway between /s/ and /ʃ/) but sometimes they do not approximate another target (e.g., a lateral lisp).

- *Suprasegmental*: Equalized stress patterns, exaggerated stress patterns, sound or syllable segmentation ("choppy" speech).

- *Self-corrections* are also considered minor errors, because they indicate that the child was not able to produce a correct response on the first attempt. So if a child self-corrects to a "minor error" response this would still not be a 1 but instead would be a 0.

<u>Score of 0 (incorrect):</u>

Production contains **more than 1 minor error**. This includes any combination of 2 or more minor errors (defined above), or 1 or more major error. Major errors can be segmental or suprasegmental:

- *Segmental*: Any omission or addition of a consonant or vowel (or syllable), any substitution of a consonant that differs from the target by more than 1 phonetic feature, and vowel substitutions (sounds like a good example of a different vowel). Also includes sound reversals/transpositions (e.g., /kæt/ ◊ [tæk]), because that is essentially two errors.

- *Suprasegmental*: Incorrect stress pattern (not merely equalized or exaggerated stress). Applies only to words or phrases consisting of more than 1 syllable.

SCORE = 0	Examples	SCORE = 1	Examples
More than one sound in error (distorted, added, substituted, omitted)	kæt ◊ gæd ˈbʌtɚflɑɪ ◊ ˈbætɚfɑɪ kæt ◊ tæk		
Omission of sound or syllable	kæt ◊ kæ ˈbʌtɚflɑɪ ◊ ˈbʌflɑɪ ˈbʌtɚflɑɪ ◊ ˈbʌtɚfɑɪ		
Addition of sound or syllable	kæt ◊ kætəl ˈbʌtɚflɑɪ ◊ ˈbʌtɚflɑɪp	Consonant distortion: Sounds like a bad example of target consonant, or between target and other consonant (e.g., excessive plosive release/aspiration; lateral lisp, excessive lengthening)	kæt ◊ kæt^h sʌn ◊ sʌ̯ n sʌn ◊ sʌ̪ n s/θ? ˈbʌtɚflɑɪ ◊ ˈbʌtɚf:lɑɪ

Vowel “substitution”: Sounds like good example of different vowel.	kæt ◊ kɪt ˈbʌtɚflaɪ ◊ ˈbætɚflaɪ	Vowel “distortion”: Sounds like bad example of target vowel, or between target and other vowel. Also includes excessive lengthening.	kæt ◊ kæt æ/ɛ? ˈbʌtɚflaɪ ◊ ˈbʌtɚflaɪ ʌ/ɪ? kæt ◊ kæ:t **NOT:** kæt ◊ kæs æ/ɛ? ˈbʌtɚflaɪ ◊ ˈbʌtɚfaɪ ʌ/ɪ?
Gross consonant error: More than 1 feature off target	kæt ◊ kæf, bæt, gæd ˈbʌtɚflaɪ ◊ ˈbʌzɚflaɪ	Minor consonant error: No more than 1 feature off target for 1 consonant (may be perceived as substitution).	kæt ◊ gæt, kæp ˈbʌtɚflaɪ ◊ ˈdʌtɚflaɪ, ˈmʌtɚflaɪ **NOT:** kæt ◊ gæs, tæp (2 minor errors = 0) ˈbʌtɚflaɪ ◊ ˈtʌtɚflaɪ (2 features off target = 0)
Gross prosodic error: Incorrect stress pattern (not merely equal stress)	ˈbʌtɚflaɪ ◊ bətɚˈflaɪ ˈbʌtɚflaɪ ◊ ˈbʌtɚˈflaɪ ˈbeɪbi ◊ beɪˈbi	Minor prosodic error: Equal stress, exaggerated stress, syllable segregation, slow rate.	ˈbʌtɚflaɪ ◊ ˈbʌˈtɝˈflaɪ ˈbʌtɚflaɪ ◊ ˈbʌ(.)tɚ(.)flaɪ **NOT:** ˈbʌtɚflaɪ ◊ bʌ(.)tɚ(.)ˈflaɪ (2 prododic errors = 0) ˈbʌtɚflaɪ ◊ bætɚˈflaɪ (vowel error + prosodic error = 0)
Sound error plus prosodic error (e.g., syllable segregation, equal stress pattern)	ˈbʌtɚflaɪ ◊ ˈbæˈtɝˈflaɪ ˈbeɪbi ◊ ˈbeɪ(.)ˈbi	Restart after partial attempt (no errors in first *complete* attempt)	kæt ◊ t … kæt kæt ◊ k … kæt
Any other errors that do not qualify for a 1 (e.g., unintelligible; two minor prosodic errors)		Self-correction (no errors in self-correction)	kæt ◊ kæf… kæt

General Scoring Rules & Procedures

1. Generally, **judge the first attempt** by a child. Self-corrections lose a point.

- ***NOTE***: If there is overlap between speakers (pre-recorded model and child) so that you can’t judge the child’s attempt, then score the second attempt but subtract one point. The reason is that children are supposed to wait to repeat, and overlapping responses indicate failure to wait. So if the second response is correct (would be a 2), then give only a 1. If the second response is a minor error (i.e. 1), then give a 0. Do not go below 0 (0 is the lowest possible score). *Make a note when this happens*.

1. **Dialectal variations or normal speech phenomena are not considered errors**. You will need to **use your knowledge of normal, non-disordered speech** and its contextual variations to make these judgments. Examples:

- Some vowel reduction in unstressed syllables is normal.

- Tapping of intersyllabic /t/ or /d/ is normal. If a child taps when the model does not, or vice versa, that is acceptable and not considered an error for our purposes.

- Unreleased stop at the end of a word is normal, as is unreleasedness of the first stop in a two-stop sequence (e.g., *'act'*).

- Partial devoicing of word-final voiced stops, fricatives and affricates is normal. Complete devoicing is not.

- Contractions are common and interchangeable in typical speech, and so should not be considered incorrect when the child's response differs from the prerecorded model (assuming no other errors). For example, a child saying *"It's"* instead of *"It is"* is OK, as is the reverse (saying *"It is"* instead of *"It's"*). Same for other contractions such as *"do not"* vs. *"don't"*.

- For the purpose of this scoring system, we will consider syllable-final rhotics to be part of a rhotic diphthong or rhotic monophthong rather than as consonants or as added vowels. That is, the word *"where"* would be considered 1 syllable (/wɛɚ/) in which the /ɛɚ/ sequence is considered a diphthong (1 syllable). Words like *"sister"* are considered to end in a rhotic monophthong (/sɪstɚ/). Deduct points for syllable additions <u>*only*</u> if a child produces this with two clearly distinguishable syllables to the point where it no longer sounds normal (e.g., /wɛ.ɚ/ for *"where"*). Keep in mind that a changing quality is inherent because they are considered diphthongs (which may sound like an added "half-syllable", as for vowels preceding syllable-final lateral /l/ (e.g. *"feel"* /fiᵊɫ/ or regular, non-rhotic diphthongs such as /ɔɪ/ in *"toy"*).

- There are many other examples of typical alterations of sounds that happen as normal speech phenomena, and these should not be considered errors. **Use your knowledge of normal, non-disordered speech** and its contextual variations to make these judgments.

2. Targets are elicited via a repetition task, therefore ***judgment is relative to the model***. For example, if the model uses atypical or exaggerated prosody and the child imitates that, this is not an error on the child's part. Be sure to *make a note when this happens*.

3. **Make notes** about observations that may be relevant. No need to go crazy with notes, but please make notes about the following:

a. If you are unsure about a score, please make a note to describe the error and/or what was confusing. These notes will help us resolve any discrepancies that may arise.

b. Errors that could be morphological or syntactic errors. For example, if a child says *"I can play with the iPad"* for the target *"Can I play with the iPad?"*, the syllable reversal could be a language error. Similarly, the syllable omission in "*What you want to drink?"* for *"What do you want to drink?"* could be a language error. We nevertheless score these as speech errors, but we want to be able to separate these types of errors if needed, so please add a comment (LANG?).

c. Anything that might affect validity of the scores. For example, background noise, poor recording quality, silly voice/yawning/giggling/crying, etc.

d. <u>No need to provide a transcription</u>, in the interest of efficiency/time management.